

THE DEVELOPMENT OF THE SOVIET MACHINE TOOL INDUSTRY
1917 - 1941

Julian M. Cooper

Thesis submitted for the
degree of Doctor of Philosophy
in the Faculty of Commerce
and Social Science, University
of Birmingham.

September 1975

UNIVERSITY OF
BIRMINGHAM

University of Birmingham Research Archive

e-theses repository

This unpublished thesis/dissertation is copyright of the author and/or third parties. The intellectual property rights of the author or third parties in respect of this work are as defined by The Copyright Designs and Patents Act 1988 or as modified by any successor legislation.

Any use made of information contained in this thesis/dissertation must be in accordance with that legislation and must be properly acknowledged. Further distribution or reproduction in any format is prohibited without the permission of the copyright holder.

Synopsis

The Development of the Soviet Machine Tool Industry, 1917-1941

Julian M.Cooper

The thesis is devoted to an examination of the creation and development of the Soviet machine tool industry in the inter-War years. It opens with a brief review of the low level of machine tool building before the October Revolution, and then considers the revival and changing priorities of the industry during the 1920s. After a review of the intensive development of the branch during the first three Five-year Plans, particular aspects are considered in detail. The overall strategy of the industry , involving decisions relating to production specialisation and technology , is analysed, together with a study of the role of process and parts specialisation. A major problem facing the industry was that of the choice of machine tool technology; this question is examined in detail, and followed by a consideration of the influence of technical progress, and the creation of a research and development system in the branch. The limited role of foreign technical assistance and the much greater role of imports are discussed. Further chapters are devoted to the problems of developing a skilled labour force and of building new enterprises. It is concluded that the development of the Soviet machine tool industry was on the whole a successful achievement , offering some lessons for present-day developing countries.

ACKNOWLEDGEMENTS

This work would have been impossible without the generous assistance and encouragement over a number of years of colleagues in the Centre for Russian and East European Studies. Above all I wish to thank Professor R.W.Davies for his patient supervision and for valuable assistance in acquiring the skills of research work. I am also indebted to John Grayson for providing the initial stimulus to work on this topic and much useful advice on technical questions. I have gained much from many discussions with Mike Berry on his research into the post-War Soviet machine tool industry. The Centre Science and Industry Seminar in its early years also provided many useful insights. Finally, I wish to thank a former member of the Centre, Dr.Yalçin Küçük, for many stimulating discussions in the early stages of this work , which proved of great value in providing general orientation. All the conclusions of this work are, of course, entirely my own.

J.M.C.
September 1975
Centre for Russian and
East European Studies,
University of Birmingham.

CONTENTS

Introduction	1
--------------------	---

Chapter

1. Machine Tool Building in Russia before the Revolution....	1
2. Continuity and Change - Soviet Machine Tool Building during the 1920s.....	16
3. From 'Stankotrest' to the People's Commissariat of Machine Tool Building - a General Review of 1929 to 1941.	58
4. The Strategy of Development of the Soviet Machine Tool Industry.....	99
5. Specialisation by Process - the Case of the Central Foundries.....	163
6. Specialisation by Parts in Theory and Practice.....	188
7. The Choice of Machine Tool Technology.....	218
8. Some Aspects of Technical Progress in the Machine Tool Industry.....	283
9. The Role of Foreign Technical Assistance and the Transfer of Foreign Technology.....	333
10. Machine Tool Imports and the Struggle for Economic and Technical Independence.....	354
11. The Labour Force and the Development of the Machine Tool Industry.....	379
12. Investment and Construction in the Machine Tool Industry.....	402
13. The Economic Performance of the Machine Tool Industry..	411
14. Conclusion.....	428

Appendix

1. The Administration of the Machine Tool Industry and the Enterprises involved in Machine Tool Building.....	437
2. Variants of the Five-year Plans for Machine Tool Building.....	448

Appendix

3.	The Structure of Machine Tool Installations, 1918-1934...	458
4.	A Comparison of the Soviet and American Machine Tool Stocks.....	483
5.	Military Production and the Demand for Machine Tools...	497
6.	A Note on 'Continuous Flow' Organisation in the Engineering Industry.....	513
7.	The Machine Tool Building Activities of the Central Institute of Labour.....	521
8.	A Chronology of the Main Events in the Development of the Machine Tool Industry.....	527
	Statistical Appendix.....	530
	Bibliography.....	585

INTRODUCTION

This thesis is devoted to an examination of the formation and development of the machine tool industry in the Soviet Union in the inter-War years. It provides an historical review and also a study of a number of particular features of the organisation and economics of the industry, including the specialisation of production, the choice of technology, problems of technical progress and the role of imports and foreign technical assistance.

The machine tool is the basic production equipment of the engineering industry. The appearance and development of machine tool building was a crucial element of the Industrial Revolution in England in the late 18th and early 19th centuries; as Marx wrote in Capital, it was only the construction of machines by machines which gave modern industry a fitting technical foundation and allowed it to 'stand on its own feet'. The great industrial strength of Britain in the nineteenth century, and later of Germany and the United States, was founded on the possession of a strong machine tool industry, which produced the technical means required for raising productivity throughout the economy. But the possession of a powerful machine tool industry gave two further advantages of immense importance for securing economic and political strength on a world scale; first, it secured a high degree of technical independence from other countries; second, it provided a vital source of equipment for building up a modern, machine based defence capacity, and a related ability to quickly expand military production in the event of war. These considerations are vital to an understanding of the role of machine tools and machine tool building in Soviet industrialisation. The acquisition of a capacity to independently produce machine tools was not just an element of an economic development strategy, it was also a matter of crucial strategic importance for the Soviet Union attempting to build the foundations of a socialist society in the circumstances of capitalist encirclement.

It is a basic premise of the present work that the development of Soviet machine tool building cannot be understood in isolation from this fact of the international environment in which the Soviet Union found herself in the pre-War years. At least three industrially advanced capitalist countries possessed strong machine tool industries developed over a number of decades, each having certain characteristic features of organisation and type of product. For the Soviet Union these capitalist machine tool industries were a source of supply of industrial equipment, and also models of possible industrial forms which could, or could not, be replicated by the domestic machine tool branch. The machines themselves were often regarded critically, but were purchased and used. Forms of industrial organisation were another matter, however, in so far as they bore the stamp of the capitalist social relations within which they developed. Thus we are concerned here with the Soviet perception of these forms of organisation and the learning process by which it was determined what features were specific to machine tool building as an activity, and what features were characteristic of the capitalist system as such. In a number of sections, therefore, a quite detailed analysis is provided of the contemporary practices of the machine tool industries of Germany, the United States and Britain, with particular attention to the basic tendencies of development. But the interaction of two different economic systems had other implications in the 1930s. Given that the Soviet Union was attempting to achieve the technical-economic level of the industrially advanced capitalist countries, it could not ignore the current course of development of these countries; the state of health of their economies and the rate and forms of technical progress. In the period we are concerned with the overriding fact was the economic crisis which convulsed the capitalist economies at the very time when Soviet industrialisation was at its most intense phase. An attempt is made to analyse the interaction of the crisis and Soviet machine tool building, with emphasis on the question of technical progress.

There has been no work in English specifically devoted to the early years of the Soviet machine tool industry. The only book to consider certain aspects of

study. Another quite useful work is the short book by M.S.Zhed' published in 1946¹. This is primarily devoted to a review of the economics of the machine tool and tooling industry, but also has a short historical introduction containing some material on the pre-War period not obtainable elsewhere. Mention must also be made of the only history of the Russian and Soviet engineering industry as a whole². This book by Rozenfel'd and Klimenko is a comprehensive and scholarly work containing useful sections on the machine tool building branch.

With the exception of the last named book all the works mentioned were published before 1960. Since then no new books have appeared, but in recent years there have been signs of a revival of interest in the history of the machine tool industry with the appearance of a number of doctoral theses and articles. Examples are Kuznetsova's study of some aspects of the industry during the First Five-year Plan period³, Volkova's work on the Moscow Party organisation and the development of the industry in the same period⁴, Puchko's thesis on the Ukrainian machine tool industry⁵, and Zinich's articles on the machine tool industry during the War years.⁶ This recent work makes much greater use of contemporary primary source material, including archive sources, and is generally of a higher academic level than all previous studies.

Other sources used include factory histories, over a dozen of which have appeared since the War, including several of local, republican publication. These histories of machine tool factories tend to be rather superficial, but quite substantial monographs have been written on at least two leading enterprises, the imeni Sverdlova works in Leningrad⁷ and the Khar'kov drilling machine factory.⁸ Some recently published memoirs have also provided useful material on the machinetool industry.⁹ The primary sources employed in the thesis are contemporary newspapers and journals, above all Za Industrializatsiyu, the main industrial paper of the period (from 1937, Mashinostroenie), and the machine tool industry's

1. Zhed', M.S., Voprosy ekonomiki stankoinstrumental'noi promyshlennosti, M., 1946.
2. Rozenfel'd, S.Ya. and Klimenko, K.I., Istoriya mashinostroeniya SSSR, M., 1961.
3. Kuznetsova, N.V., Bor'ba rabochego klassa za sozdanie novykh otraslei promyshlennosti v gody pervoi pyatiletki (iz materialakh stankostroeniya), Aftoreferat dissertatsii, M., 1973.
4. See Istoriya KPSS - marksizm-leninizm v deistvie, sbornik statei, M., 1974, pp. 137-154.
5. Puchko, A.A., Razvitie stankostroitel'noi promyshlennosti na Ukraine v dovoennyi period, 1917-1940, Aftoreferat dissertatsii, Kiev, 1970.

own journal, Stanki i Instrument, founded in the summer of 1930. A particularly valuable source is the verbatim report of the first All-Union Conference on Machine Tool Building of June 1933.¹⁰ In general it must be said that the material proved to be much richer than was thought likely at the outset of research

For a number of reasons the thesis is devoted exclusively to the production and use of metal-cutting machine tools. It does not discuss metal-forming machine tools (i.e. presses, hammers, bending machines, etc., working metal by the exertion of pressure) or the cutting tools used by the machine tools. Metal-forming machines were built on a relatively small scale in the period in question and at different enterprises from cutting-type machines. Cutting tools are of course crucial to the operation of machine tools, but their production is a different activity with its own distinct features. In the case of Soviet industry the specialised production of cutting tools was organisationally closely related to the building of machine tools, but a very large proportion of tools were in fact made by engineering factories themselves and by other non-specialised producers.¹¹ Finally, it is evident that information on the production of metal-forming machines and tooling is very sparse in comparison with that available on cutting machines.

Metal-cutting machine tools (metallorezhushchie stanki) shape metal by applying a moving cutting tool to a stationary workpiece, or a stationary tool to a moving workpiece. The cutting tool is generally made of very hard alloy metal or, in the case of grinding machines, of abrasive materials. For machines of the lathe group the workpiece is usually rotated between centres and cut by a stationary tool; in the case of turret lathes a number of tools are held in a rotating head, and semi-automatic and automatic lathes provide different degrees of automation of the processes of tool selection and the feed of the workpiece. For machines of the milling group the metal is cut by rotating milling cutters, while for drilling machines holes are cut by a rotating cutting tool. A number

6. Notably, M. S. Zinich, "Iz istorii stankostroeniya i tyazhelgo mashinostroeniya v pervoi period Velikoi Otechestvennoi voyny", Istoriya SSSR, 1971, No. 6.

7. Borisov, G. and Vasil'ev, S., Stankostroitel'nyi imeni Sverdlova, L., 1962.

8. Khar'kovskii Stankostroitel'nyi, Khar'kov, 1968.

9. Notably, Gudov, I., Sud'ba rabochego, M., 1970.

10. Stenogrammy - pervogo vsesoyuznogo soveshchaniya po stankostroeniyu, n.d.. duplicated. (in the State Public Science and Technology Library, Moscow).

of types have a reciprocating action, involving the backward and forward motion of the cutting tool over the workpiece, or of the workpiece under the tool. Thus planing machines are generally large and have a fixed tool(s) and a workpiece attached to a reciprocating bed, whereas shaping machines are smaller and have a reciprocating tool. Slotting machines work on a similar principle to shaping machines, but make slot-shaped cuts. Gears are cut on a range of different types of gear-cutting machines, often involving milling, shaping, planing and other basic processes. Grinding machines take a variety of forms depending on the nature of the workpiece and the type of work to be performed, the basic types being cylindrical, surface, internal, centreless, and tool grinding machines. Broaching machines have an elongated, toothed cutting tool which is pushed or pulled over the surface to be cut. Honing machines finish or enlarge holes by an abrasive action. Within each basic type group there are very many variants and different sizes: the great diversity of products is one of the characteristic features of the machine tool industry.

The thesis begins with a brief background review of the state of machine tool building in Russia before the October Revolution. The developments of the 1920s are then discussed, showing the continuity with the past and the steps towards the formation of a specialised industry. Chapter Three provides an overview of developments between 1929 and 1941. The following ten chapters examine in detail particular aspects of the machine tool industry's development in this period. Some factual issues are discussed in appendices, notably the administrative arrangements of the industry, its factories, the different variants of the Five-year Plans for machine tool building, and the structure of machine tool installations during the period 1913-1934. Some problems are also examined in detailed appendices: comparison of the Soviet and American machine tool stocks, military production and the demand for machine tools and the role of continuous flow production. A summary chronology is provided in Appendix Eight, and all the main statistical materials are gathered in a final Statistical Appendix.

11. Almost two-thirds of all tools were produced outside the specialised industry in 1940 - Zhed', op.cit., p.18.

Chapter 1

MACHINE TOOL BUILDING IN RUSSIA BEFORE THE REVOLUTION

The First Russian Machine Tool Builders

The beginnings of machine production in Russia date from the time of Peter the Great and were closely linked with the production of armaments. The very first Russian machine tools were built by a talented engineer, A.K.Nartov, in the royal workshops. In 1712 Nartov built a copying lathe incorporating a mechanical slide rest, long before the English machine builder Maudslay, who is generally credited with the invention of the modern machine tool.¹ Nartov's work had very little influence on subsequent machine development, however, while Maudslay's provided one of the crucial technical means associated with the Industrial Revolution. The early arms factories established in the eighteenth century built many of their own machine tools, some of great originality, and the first private enterprise machine tool building took place at the 'Berda' factory, founded in St.Petersburg in 1790. This factory was one of only two enterprises in Russia in the nineteenth century which trained workers in the arts of machine tool building: it took from ten to fifteen years to fully train a skilled craftsman.²

Before the Crimean War the Russian engineering industry was extremely weak and needs were met primarily from imports. After the War the Tsarist government took measures to promote ship-building, railway construction and military production. Tariffs on machinery were introduced in 1863 and were particularly effective in fostering the domestic production of rail transport machinery. The 1890s were years of quite rapid development of machine building, output rising from 50 million rubles in 1887 to 209 million rubles in 1900.³ The industrial crisis of 1900 to 1903 ended the decade of advance; many factories closed down, while a general process of product diversification intensified the already marked universalism of production. It was not really until 1909 that the Russian

1. Britkin, A.S. and Vidonov, S.S., Vydayushchiysya mashinostroitel' XVIII veka: A.K.Nartov, M., 1950, p.24.

2. Ocherki istorii tekhniki v Rossii, M., 1973, p.330.

3. Rozenfel'd, S.A. and Klimenko, K.I., Istoriya mashinostroeniya SSSR, M., 1961, p.47.

engineering industry really resumed its expansion. Many factories were enlarged and reequipped at this time giving rise to a large demand for industrial equipment. In the immediate pre-War period new , advanced-technology branches of machine building began to develop, notably the building of motor vehicles and aircraft. In 1914 the 'Russe-Baltic' factory built 140 cars, incorporating a large share of imported parts and materials. The low level of vehicle production , a branch which exerted a powerful influence on machine tool building and production technology in general before the First World War, deprived the Russian machine tool builders of a vital stimulus to development. The electrical engineering industry, which grew rapidly in the pre-War decade predominantly under the control of German capital, was marked by a high technical level, but many components were imported and technical skills were largely supplied by foreign specialists. A similar phenomenon was typical of another branch which in the West exerted a major influence on machine tool design. This was sewing machine building , concentrated at one large factory at Podol'sk owned by the American Singer company. This high precision production probably had little influence on the Russian engineering industry, because Singer imported almost all the equipment and many of the semi-fabricates and parts, while all design work was undertaken in the USA.¹

The technologically most advanced and best equipped Russian owned engineering factory before the Revolution was probably the small Semenov works in St.Petersburg. This factory built automatic cigarette making machinery of independent design on a batch basis using American machine tools of the latest types. In 1910 it was reported that Semenov was planning to start the production of American 'Prentice' lathes, but it is not known whether this was achieved.² Other branches of machine building which exerted an influence on machine tool building in the West were almost non-existent in Russia: these included bicycle making, the building of printing machinery and of typewriters.

-
1. Rozenfel'd and Klimenko, op.cit, p.107. This experience was not unique to Russia. The large Singer works in Scotland was equipped largely with machines made by Singer themselves and did little to advance the British machine tool industry. See Saul, S.B., Technological change: the United States and Britain in the 19th century, London, 1970, p.161.
 2. The Iron age, 16.6.1910, pp.1462-1463 (After the Revolution this factory became the imeni M.Gel'tsa tobacco machinery works)

Machine Tools in Russian Industry before the First World War

Throughout the entire period from the initial establishment of the Russian engineering industry to the beginning of the First World War the overwhelming majority of machine tools in use in industry were of foreign manufacture. A survey undertaken in 1875 by the Russian Technical Society revealed that almost all machine tools were of foreign origin, mainly imported from Britain.¹ The total number of machines at this time was very small: in 1871 there were 165 metal working factories having an average of twenty machine tools each, giving a total stock of over 3,000 units.² In the mid-1880s the structure of the stock was approximately as follows: lathes 45 per cent of the total, drilling and boring machines 18 per cent, planing and shaping machines 20 per cent, milling machines 5 per cent and gear-cutting machines 3 per cent.³ The general lack of specialisation of industry discouraged the use of specialised types of machines then being developed in the United States and Britain.

In the last decade of the nineteenth century the British machine tool builders, who had supplied the bulk of machines imported into Russia up to that time, began to be strongly challenged by German firms. While German machines were no better in design or quality than those of Britain or America, the German suppliers had the advantage of closer links with the Tsarist government and considerable capital holdings in machine using branches of industry. There were charges that Germany sold inferior quality machine tools to Russia at prices below those charged on her own domestic market, some of the machines taking the form of special 'export goods'.⁴ In the immediate pre-War period the American machine tool industry began to show increased interest in the Russian market and made some inroads into the German market share.

The relative proportions of machine tools built in Russia and imported are shown in value terms in Table 1.II, which clearly reveals the substantial dependence on imports and the fact that this dependence did not decrease in the immediate pre-War period. The proportions in physical terms are not known, but

1. Rozenfel'd and Klimenko, *op cit*, p.90.

2. Strumilin, S.G., *Ocherki ekonomicheskoi istorii Rossii*, M., 1960, p.439.

3. Aizenshtadt, L.A. and Chikhachev, S.A., *Ocherki po istorii stankostroeniya SSSR*, M., 1957, p.99.

an approximation is provided by data from the 1932 Census of metal-working equipment. This provides the following information about the machines in the civilian machine tool stock of the country in April 1932 which were installed before 1914.

Table 1.I

The pre-War Machine Tools in the Stock of April 1932

Year of installation*	Total no. in stock	Foreign machines		Origin of foreign machines (% of foreign machines)			
		No.	% of total	Germany	USA	Britain	Other
Before 1900	11,796	8,479	71.9	48.9	11.7	18.1	20.3
1901 - 1907	8,217	5,834	71.0	50.0	14.3	10.1	25.6
1908 - 1913	14,805	11,195	75.6	46.0	25.5	9.0	27.6

* or year built in a few cases where year installed not known.

Source: compiled from Sotsialisticheskoe stroitel'stvo SSSR, M., 1935, p.72.

This information must be treated with caution because the rate of scrapping of machines of different countries of origin between 1913 and 1932 is not known. Furthermore, the census does not cover enterprises engaged in military production, or those Russian engineering enterprises located beyond the boundaries of the USSR, in particular those located in Poland. Other sources refer to a much higher share of German imports, e.g. a contemporary source stated that the German proportion of machine tool imports in the years 1906-1910 averaged 76.5 per cent by weight and 78.4 per cent by value.⁵ It is possible that German machines were of lower quality than those of Britain and America and that a larger proportion were removed from the stock between 1913 and 1932. The total magnitude of the machine tool stock on the eve of the War is not known, but a survey in 1908 gave a total of 75,000 metal-cutting machine tools in the economy and 18,000 units of metal-forming equipment.⁶

Machine Tool Building in Russia before the First World War

Disregarding the early efforts of individual inventors and the government

4. Plotnikoff, M.S., "The mechanical industry in Russia", The Russian Economist, Vol.1, No.4, July-Sept., 1921, p.1160.

5. Rozenfel'd and Klimenko, op cit, p.106, citing a report of 1913.

6. Narodnoe khozyaistvo SSSR v 1958godu, M., 1959, p.156.

military enterprises, commercial machine tool building in Russia effectively dates from 1870, when a number of domestically produced machines were shown at the All-Russian Manufacturing Exhibition, including radial-drilling and planing machines built by the Bromley factory in Moscow and machines built by the Lessner and Nobel factories of St. Petersburg.¹ New producers exhibiting in 1882 at a national industrial exhibition in Moscow included the Putilov and Veikhel't factories and a number of newly established firms, including the Grachev works in Moscow and 'Gerlyakh and Pul'st' of Warsaw.² The railway boom of the 1880s and 1890s, coupled with the introduction of a tariff on imported machinery provided some incentive for domestic machine tool building towards the end of the nineteenth century and the number of factories involved increased. The machines were generally of a heavy and simple kind suitable for use in railway repair shops. Two ambitious attempts to establish specialised machine tool factories met with failure. The French owned Khar'kov locomotive works had a special machine tool building shop from the mid-1890s which built a wide range of machines, including light lathes, radial drilling machines and special equipment for working armour plate. This enterprise proved unprofitable and it was closed down after fire destroyed the shop in the early 1900s.³ A similar story was repeated at the Chernomorsk factory in Nikolaev, a factory built at the end of the 1890s, with the involvement of French capital, specifically for machine tool building. The firm built milling machines and turret lathes of French design, but despite its modern equipment and government support sales were inadequate and after a fire in 1904 the works was closed down.⁴ A major factor in the failure of these attempts to establish specialised machine tool building in Russia was clearly the abrupt contraction of the market after 1900. At the 1896 Nizhny Novgorod Exhibition twenty one Russian machine tool builders were represented, the majority of exhibits being lathes.⁵ But during the years of the depression from 1900 to 1908 the output of machine tools contracted and the number of factories involved fell

1. Aizenshtadt and Chikhachev, op cit, p.120.

2. ibid.

3. ibid., p.148; Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No.9-10, p.82.

4. ibid.

5. Aizenshtadt and Chikhachev, op cit, p.129.

sharply: output in 1908 was only half that of 1900.¹

During the five years before the outbreak of war machine tool building developed quite strongly. This expansion is shown in Table 1.II. Output rose by 2.2 times between 1910 and 1913, while imports rose by over 2.8 times. Of the forty enterprises building machine tools in 1914, fifteen were workshops of a semi-handicraft nature employing up to fifteen workers and building machine tools as part of a diverse range of metal products. A second group of fifteen rather larger factories having over a hundred workers also built some machine tools alongside other products - many of this group were located in Poland and Latvia. A third group was composed of a number of very large engineering works which built machine tools to meet their own demands, but occasionally for the market when conditions were favourable. This group included the Putilov works and a number of railway equipment factories. A final small group of four enterprises, (the 'Gerlyakh and Pul'st' factory in Warsaw, the Bromley Brothers factory in Moscow, the 'Phoenix' works in St.Petersburg and the 'Fel'zer' works in Riga) was the most important, but the first named was the only one which could be considered a specialised machine tool firm. Machine tools represented about a third of the output of the other three enterprises in 1913.¹ The 'Gerlyakh and Pul'st' factory specialised in machine tool building from 1908; equipped with modern American machine tools, it produced a range of types, some on a batch basis. Products built included milling machines, which were sold to firms making guns, ammunition and sewing machines, suggesting a high level of precision. This factory had a basic capital of one million rubles in 1913 and employed 750 workers.² The 'Bromley' factory was founded in 1857 and built machine tools from 1870, mainly for the railway repair shops. In 1913 1,300 workers were employed and capital amounted to three million rubles. Output in that year included 92 machine tools of twelve different types, indicating a low level of specialisation.³ The 'Phoenix' works of St.Petersburg was founded by a Scot, James Muirhead, in 1867 and began building machine tools to individual order in the 1890s. In 1897 it became a joint

1. Aizenshtadt and Chikhachev, *op cit*, pp.145-147.

2. *Ibid.*, pp.148 and 154; *The iron age*, 16.6.1910; pp.1461-1462.

3. Aizenshtadt and Chikhachev, *op cit*, pp.149-150; Omarovskii, A.G., *Sovetskoe stankostroenie i ego rol' v industrializatsii strany*, M., 1948, pp.153-160.

stock company and from this time the British machine tool firm 'Greenwood and Batley' began to acquire shares and later gained financial control. The majority of the administrative personnel were British. Machine tools, generally of a heavy and simple type, were built primarily to the order of the Navy and the railway workshops, the models being copies of old foreign designs. On the eve of the War 750 workers were employed.¹ Foreign influence was also dominant at the Riga 'Fel'zer' works, where a large proportion of the technical personnel and workers were from Germany. This factory, founded in 1874, built machine tools from 1896, mainly of heavy types for railway workshops, alongside diesel engines, turbines, boilers and pumps. In 1913 this works employed 1,200 people.²

The Influence of Government Policy on Russian Machine Tool Building

The Tsarist government directly influenced the development of machine tool building through two channels, namely tariff policy and the placing of orders. Although ostensibly protective in intention, both these factors did little to foster the domestic production of machine tools of a quality adequate to compete with imported products and on balance may have exerted a negative influence. During the 1860s and '70s machinery and equipment entered Russia duty free, but in 1882 a tariff of 90 kopecks per pud was introduced for machinery and of 1 ruble 40 kopecks for locomotives.³ This measure did help to establish the domestic production of rail equipment, and also created a demand for relatively simple, heavy machines for equipping the railway repair workshops. By the 1890s the tariff had been raised to 4r. 50k. per pud, and in 1910 the rate stood at 4r.20k., but if additional necessary minor costs were added the effective rate was about 5 rubles per pud.⁴ But whereas normal European tariff practice attempted to discriminate between types of machines, with differential rates according to weight and complexity, the Russian tariff took the form of a single standard rate per unit weight of machine. This policy had the inevitable outcome of protecting the building of heavy, simple machine tools, while lighter, more complex

1. Borisov, G. and Vasil'ev, S., Stankostroitel'nyi imeni Sverdlova, L., 1962, pp.3-63.

2. Aizenshtadt and Chikhachev, op cit, pp.153-154; Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No.9-10, p.82.

3. Ocherki istorii tekhniki v Rossii, op cit, p.331.

4. Rozenfel'd and Klimenko, op cit, p.106.

Table 1.II

Russian Machine Tool Building - Factories, Production and Imports
1908 - 1913

Year	Number of factories	Production ('000pre-War r.) within boundaries of:		Imports ('000pre-War r.)		Domestic prodn.as per cent total sales
		Russia	USSR ¹	Including duty	Excluding duty	
	(1)	(2)	(3)	(4)	(5)	(6)
1908		1,881.3	671.8			
1910	34	1,507.6	778.7	6,956	4,637	17.8(24.5)
1911	35	2,374.4	1,472.7	11,118	7,412	17.6(24.3)
1912	42	2,813.2	1,820.3	12,057	8,038	18.9(25.9)
1913		3,347.0	2,182.0 ²	19,182	12,788	14.9(20.7)

1. Pre1940 boundaries.

2. In physical terms 1,490 units (or 1,800 , within present-day boundaries) (Zhed'M.S., Voprosy ekonomiki stankoinstrumental'noi promyshlennosti, M., 1946, P.6; Narodnoe khozyaistvo SSSR v 1958g., M., 1959, p.231)

Sources:

- (1) Aizenshtadt and Chikhachev, op cit, pp.139 and 145.
- (2) Omarovskii, op cit, p.46; 1910-13 data also given by Sistema i organizatsiya, 1926, No.4, p.11.
- (3) Omarovskii, loc.cit.
- (4) Calculated from Aralov, S.I. and Shatkhan, A.S. (eds.), Promyshlennyyi import - itogi i perspektivy, M.-L., 1930, p.140. This source estimates that customs duty and various commercial expenses were equivalent to half the value of machine tool imports. The source also stresses the approximate nature of the import data.
- (5) as (4).
- (6) Total sales taken as production (2), plus imports including duty (4).
Proportion of sales plus imports excluding duty shown in brackets, (...).

machines could not be profitably built domestically and needs were met to a considerable extent by imports. The systematic bias against the domestic production of progressive types is illustrated by the following table:

Table 1.III

The Duty on Imported Machine Tools

Type of mc.tool	Price per <u>pud</u> weight	Duty as a percentage of the price of the machine		
		Weight categories (<u>pud</u>)		
		Up to 100	100 - 600	600 or more
Lathes	Over 15r.	20	-	-
	10 - 15r.	-	32	-
	10r.or less	-	50	60
Planing machines	Over 11r.	27	-	-
	10r.or less	-	37	71
Drilling machines	Over 11r.	27	-	-
	10r.or less	-	50	60
Milling machines	Over 15r.	20	21	-
	15r.or less ^s	30	-	-
Special machines	Over 20r.	18	-	-
	20r.or less	28	-	-

Source: Aizenshtadt and Chikhachev, op.cit, p.142; original source, Vestnik inzhenerov, 1915, no.7.

Thus a light and complex (high price per unit weight) milling machine entered the country with a duty of 20 per cent of its price; but a heavy, simple lathe with a duty of 60 per cent. One writer estimated that a light (100 pud, or 1,638kg.) domestically produced lathe cost fifteen per cent more than the equivalent imported machine after payment of the duty, but a heavy lathe of 300 pud (4,912 kg.) could be produced at a price equal to that of an equivalent imported machine¹.

The action of the government ordering policy was similarly contradictory. On the one hand, the placing of orders for machines required by the railway repair

1. Byulleten' konventsii sindikatov metallicheskoj promyshlennosti, 1925-26, No.10-12; p.155.

shops and military administrations secured the Russian machine tool builders with a market and was responsible for fostering the machine tool building activity of a number of engineering factories in the 1880s and '90s. On the other hand, the system of ordering did little to encourage the building of machines of high quality or advanced design. The machines needed for the repair shops were generally of simple types of low accuracy; the orders were haphazard and, as a rule, the government adopted a policy of awarding contracts to the lowest bidder thereby providing no incentive for quality improvement.¹ This policy, not surprisingly, did not meet the interests of the machine users. During the period 1896 to 1905 the railway repair shops were obliged to buy Russian-built machines; their costs rose to the extent that they could not compete with the locomotive factories which carried out repair using imported equipment. The rail workshops therefore pressed the government to permit them to import machine tools.² The net result of the Tsarist governments policies for supporting machine tool building was probably negative. They protected the high-cost production of backward machines, while increasing the country's dependence on foreign suppliers for all but the simplest and heaviest types. The extent of this dependence was to become acutely apparent in the early period of the War.

Machine Tool Building during the War, 1914-1917.

The inadequacy of the engineering industry was brutally revealed to the Russian government in the early months of the War. The arms factories were unable to supply the required guns and ammunition, and the machine building industry was quite unable to supply the technical equipment essential for a modern war: motor vehicles, aircraft, electrical equipment and, above all, machine tools necessary to establish the domestic production of these products. The government was forced to take measures to expand the existing arms factories and to build new ones, while at the same time involving civilian private enterprise in military production. The necessary machine tools could not be supplied by Britain and France because they

1. Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No. 9-10, p. 81.

2. Aizenshtadt and Chikhachev, op cit, p. 143.

had their own urgent domestic demands to meet, while the main traditional source of supply was cut off. Thus Russia had little choice but to obtain machines where possible from the United States and Scandinavia, while at the same time the government took measures to greatly expand domestic production. In 1915 the Council of the Congress of Representatives of Industry and Trade acknowledged that machine tool building was "one of the weakest elements of Russian machine building". In August of the same year the Committee of Medium and Small-scale Industry reviewed the state of equipment of 175 small and medium enterprises in Petrograd with a view to tooling them for machine tool production: eight of them were switched to large-serial production of one type of machine.¹ It is not clear how effective these government measures were in expanding production. It appears that the new market conditions led to a sharp rise in machine tool prices and made machine tool building a profitable activity for many engineering works, some of which established large-scale production.

The primary pre-War machine tool builders, with the exception of the 'Bromley' works, contributed little to the War effort. The 'Gerlyakh and Pul'st' factory was evacuated to Khar'kov but not restored. The 'Fel'zer' factory was evacuated from Riga to Nizhny-Novgorod in 1915 and virtually ceased machine tool building.² The 'Phoenix' works cut-back machine tool building and concentrated on munitions production. But the 'Bromley' works expanded during the War and made machine tool building its main speciality. Other enterprises building machine tools during the War years included the Tula arms factory, the Singer factory at Podol'sk (making turret lathes), the Shtolle works in Moscow, the locomotive and wagon works in Sormovo, Kolomna and Bryansk, and a number of technical schools, including the Bardygina works-school in Egor'ev near Moscow.³ The main products were simple lathes and drilling machines required for munitions production.

There is some dispute as to the extent and technological level of this sudden upsurge of machine tool building in Russia during the First World War. The exact magnitude of the increase in output is uncertain, but it must have been quite substantial. The only available information is that the 1917 output exceeded the

1. Aizenshtadt and Chikhachev, *op cit*, p.155..

2. *ibid.*, p.157.

3. *ibid.*, p.156; Rozenfel'd and Klimentko, *op cit*, pp.122-123.

pre-War level by 43 per cent.¹ If 1913 prices are being employed, this would indicate an output in 1917 of about 5 million rubles. Given that engineering output as a whole in 1917 was about 70 per cent of the 1916 level², machine tool output at its peak in 1916 may have been as great as 7 million rubles.³ The engineer, Grinevetskii, in his well known work on the post-war prospects of Russian industry, admitted that machine tool building was "one of the weak and backward sectors of Russian machine building" before 1914, but claimed that during the War it "grew extraordinarily, not only quantitatively, but also with respect to quality". Many factories, he added, "undertook production of a normalised or mass type: Tula, Shtol'tse, the 'Zemgor' combines, Kramatorsk, Sormovo and the Bryansk factories built extremely intricate and complex machine tools and made better products than the majority of Scandinavian and other wartime exporters".⁴ Soviet writers consider this an exaggerated view of the wartime achievements. The products of these new producers were, they claim, predominantly simple, operational machines for military production, designed for a very limited range of work in the hands of low-skilled operators. It was this simplicity which permitted the rapid organisation of their serial production, but in terms of the design of machine tools and their quality the level of machine tool building was not enhanced.⁵ The historians of the Russian and Soviet engineering industry, Rozenfel'd and Klimenko, do acknowledge that there were some qualitative improvements, but put more stress on the organisational aspects: wartime production of machine tools was "a good school of large-serial production".⁶ However, all Soviet writers are agreed that the long-term effect of this experience of machine tool building was minimal. Most of the wartime producers dropped machine tool production after the War and the workers and specialists who had acquired some of the skills of the trade were scattered during the Revolution and the Civil War.

During the War a considerable quantity of American machine tools was imported by Russia. The quantity in physical terms is not known, but in the fiscal year 1915-1916 (1st July 1915 to 1st July 1916) the USA exported 10.3 million dollars worth of metal-working machinery to Russia, compared with 1.3 million dollars worth

1. *Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami*, M., 1930, p.150.

2. Rozenfel'd and Klimenko, *op cit*, p.126.

in 1913-14, and 2.1 in 1914-15. In May 1916 Russian imports from the USA represented 3.6 million dollars - the highest ever month's imports of machine tools by any country up to that time.⁷

The expansion of domestic production, coupled with substantial imports, led to a large increase in the size of the machine tool stock of the economy during the War years. By 1917 the stock appears to have been approximately 120,000 units,⁸ compared with 75,000 in 1908. Other evidence is provided by the 1932 census : of the 181,000 machines in the stock (civilian only) of April 1932, 57,000 were installed prior to 1918, and almost 19,000 of these, or 35 per cent, were installed during the War years.⁹ The quality of this addition to the stock is another question. While many high quality machines were almost certainly imported, notably from the USA, those domestically produced, or imported purely for meeting the short-term demands of military production, could not have been of great value to the economy in peacetime. Even Grinevetskii, usually enthusiastic about the wartime achievements, admits that the equipment installed was "too much subordinated to the ephemeral tasks of wartime",¹⁰ and this view was supported by Soviet writers today.¹¹

Machine Tool Building in Russia on the Eve of the October Revolution

In the United States and a number of West European countries machine tool building was a well-developed, specialised industry by 1917. Skills and experience had been accumulated gradually over many years, and the structure of the industry and its products had been formed under the influence of a series of new branches of engineering, notably the making of railway equipment, sewing machines, bicycles, and, above all, motor vehicles. By the outbreak of War such complex machines as automatic and semi-automatic lathes, gear-cutting machines and production grinding machines were being used in many branches of engineering and new machine tools were being designed to take full advantage of the possibilities offered by

-
3. Present day Soviet sources give an output in 1917 of only 200 units (e.g. *Strana Sovetov za 50 let.*, M., 1967, p.83) There is no indication of the origin or scope of this figure and, in view of the known pre-War output, it is probably a substantial underestimate.
4. Grinevetskii, V.I., *Poslevoennye perspektivy russkoi promyshlennosti*, M., 1922, p.42.
5. Aizenshtadt and Chikhachev, *op cit*, p.156; Omarovskii, *op cit*, p.47.
6. Rozenfel'd and Klimenko, *op cit*, p.123.
7. *American machinist*, Vol.45, 1916, pp.337-338; 554.

high-speed tools. The situation in Russia was very different. While several engineering factories had been building machine tools for a number of years, by 1917 there was only one specialised machine tool building factory and no identifiable machine tool 'industry', in the sense of a group of more or less specialised enterprises undertaking machine tool building on a regular basis. At a number of the factories which did build machine tools foreign technical specialists played an important role and the machines built were generally of foreign design. Machine tool supply in general was characterised by a very high degree of dependence on foreign producers; a dependence which government tariff and ordering policy only served to reinforce. Recognition on the part of the government and Russian industrialists of the necessity of establishing a viable domestic machine tool industry came only under the acute pressure of war. But the hastily organised production during the three years of War, while revealing the potential of Russian industry to quickly assimilate machine tool building of a fairly rudimentary nature, was not sufficient to overcome the consequences of the neglect which machine tool building had suffered in the preceding decades.

It would be wrong, however, to dismiss machine tool building in pre-Revolutionary Russia as having been so insignificant as to have had no influence on subsequent development. This view was often put forward during the Stalin period and is exemplified in the following comment by A. Zernov, a leading machine tool engineer, writing in 1932; "one may say that Soviet machine tool building received no legacy of any value from Tsarism. Pre-Revolutionary machine tool building created neither cadres of technicians and workers, nor production skills, nor a culture of machine tool building, and Soviet industry had to start from scratch".¹² The incorrectness of this position will be shown in the following chapter.

In the last days before the October Revolution, under the Provisional Government an ambitious scheme was launched by a group of prominent Russian industrialists: the creation of a corporation in Petrograd for the production of metal and wood working machinery, and small tools. It was announced in May 1917 that the new firm

8. Za Industrializatsiyu (hereafter, ZaInd.), 29.10.32. A more recent source gives an estimate of 100,000 to 120,000 units - Fedosov, A.D., Partiya Bol'shevikov i tekhnicheskogo progressa, M., 1969, p. 282.

9. Sotsialisticheskoe stroitel'stvo SSSR, M., 1935, p. 72.

headed by A.E.Putilov and backed by the Russo-Asiatic and Siberian Banks, had spent seven and a half million dollars on acquiring two engineering factories and was intending to buy a whole chain of enterprises, which were to be equipped with American machine tools.¹³ Five years earlier such a project could have transformed machine tool building in Russia and had a significant impact on the War effort; by May 1917 it was too late.

10. Grinevetskii, op cit, p.47.

11. Rozenfel'd and Klimenko, op cit, p.125; Maevskii, I.V., Ekonomika russkoi promyshlennosti v usloviyakh pervoi mirovoi voyny, M., 1957, pp.120-121.

12. Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No.9-10, p.88. This is just a particular case of a more general phenomenon of the period - a widespread tendency to downgrade the industrial level of the country before 1917. As the historian V.Lel'chuk observed in a recent work; "If one were to believe the overwhelming majority of authors, writing from the end of the 1930s to the mid-1950s, the industrialisation of the USSR developed almost from scratch". (Zak, L.M., Lel'chuk, V.S., Pogudin, V.I., Stroitel'stvo sotsializma v SSSR - istoriograficheskii ocherk, M., 1971, p.89)

13. The iron age, 5.5.1917, p.876.

Chapter 2CONTINUITY AND CHANGE - SOVIET MACHINE TOOL BUILDING DURING THE 1920sThe First Years of Soviet Power, 1917-1925.

The immediate consequences of the October Revolution were not favourable to the development of the engineering industry from the point of view of production, but this was not the primary concern of the new Soviet government. Nationalisation of the largest engineering enterprises was the first aim and this began in December 1917. In June 1918 nationalisation was extended to cover all large-scale metal working, metallurgical and mining enterprises, creating the necessary precondition for planned development of these sectors. The first steps in the direction of the formation of a new centralised administration for industry were taken, with the establishment in December 1917 of the Supreme Council of the National Economy (VSNKh) and the creation within it of the Department of Metal in 1918. Renamed Glavmetall (Glavnoe upravlenie metallicheskoi promyshlennosti) in 1921, this department was to serve as a single centre for controlling the engineering and metallurgical industries.

Production of many categories of machinery fell sharply in 1918 and this decline intensified greatly with the onset of the war against foreign intervention and the Civil War. Machine building suffered severely during this period of fighting from 1918 to 1920: production fell to an insignificant level, workers left the factories, and plant and equipment, already neglected and worn after four years of wartime use, experienced further neglect and ill-treatment through use in unskilled hands. The output of the metal working industry fell to only 7.5 per cent of the 1913 level in 1920.¹ All branches of machine building were affected, with the exception of sectors having direct military importance. This was the period of War Communism characterised by extreme centralisation of the administration of industry. The Department of Metal of VSNKh, at this time (1920) headed by E.M. Al'perovich, controlled 230 large enterprises having 270,000 workers, but only 176 of these factories were actually in service.²

Machine tool building practically ceased during this period of disruption. There was little if any demand for new machine tool equipment : the needs of priority sectors could be met by transferring machines from inactive factories. The new regime also inherited a stock of machine tools imported during 1917, but not installed. Strumilin estimated that there must have been about 200 million rubles worth of industrial machinery accumulated at the ports and factories at the time of the Revolution.³ Resources were lacking for the replacement of the considerable quantity of worn machinery in the economy . Furthermore, the production base for machine tool building itself had been reduced with the loss of Poland and the Baltic countries, which accounted for about 35 per cent of the total pre-War machine tool output.⁴ The 'Gerlyakh and Pul'st' and 'Fel'zer' factories had both been evacuated , but the former was never restored, its equipment being distributed to other enterprises. The 'Fel'zer' works was rebuilt at Nizhni-Novgorod and resumed machine tool building alongside its main activity of diesel engine building. This factory, later renamed 'Dvigatel' Revolyutsii', specialised in machine tool building for railway workshops and made eleven such machines in 1920.⁵ The 'Bromley' factory in Moscow was nationalised in November 1918 and subordinated to VSNKh under the name of the State Machine building Factory No.2. The workers had to fight off attempts to 'conserve' the enterprise because of the lack of fuel and metal.⁶ They were successful, and machine tool building was resumed during the Civil War period, when special machines were built for the munitions industry. In 1922 the factory was renamed 'Krasnyi Proletarii'. With the exception of the Tula Arms factory , all the the engineering factories which had taken up machine tool building before and during the War now dropped this activity. The 'Phoenix' works, one of the largest pre-War Russian suppliers, was put into 'conservation' until 1925. It was nationalised in July 1919 and renamed the Petrograd Machine Tool Factory imeni Sverdlova in November 1922, although at that time it was inactive.⁷ Thus the machine tool building which had sprung up

1. Rozenfel'd & Klimenko, p168.

2. *ibid*, p174.

3. Strumilin, S.G., *Izbrannye proizvedeniya*, Vol 1, M., 1963, p351.

4. Omarovskii, p49.

so rapidly during the three years preceding the Revolution, faded away with equal rapidity in the three years after it.

Despite the recognition by Lenin and other leaders that it was essential to create a new material and technical basis for the socialist society, founded on large-scale machine production, the primary task of the years immediately after the Civil War was the restoration of industry on the technical basis inherited from Tsarist Russia. Therefore, the machine building industry and in particular those branches creating means of production, did not play a leading role during the first years of the New Economic Policy. Government priorities were rather measures directed towards maintaining and strengthening the support of the peasantry, which in practical terms meant more emphasis on light industry and agriculture than on heavy industry and machine building. These factors conditioned the restoration of the engineering industry and account for its relatively slow progress: industry as a whole attained 75 per cent of its prewar output by 1924/25, whereas machine building produced only 58 per cent of its 1912 output in the same year.⁸ In these circumstances there was little possibility of a large-scale renewal of industrial plant and equipment, despite its worn condition. A large proportion of the capacity of the engineering industry was in fact deliberately removed from service at this time: of the 118 engineering factories of Union status under Glavmetall in 1923/24, only 77 were in operation, the remainder being in a state of conservation to be gradually brought into service as demand for machinery revived.⁹ In these circumstances it is not surprising that little if any official attention was paid to machine tool building during the first stage of NEP.¹⁰

5. Aizenshtadt & Chikhachev, p160.

6. *Slavnye traditsii*, M., 1957, pp18-19.

7. Borisov & Vasil'ev, pp94-100.

8. Rozenfel'd & Klimenko, p181.

9. Makeenko, M.M., *Ocherk razvitiya mashinostroeniya v 1921-1928gg*, Kishinev, 1962, p17.

10. Omarovskii, p49, citing an archive source, claims that there was a Party and government decree in 1923 calling for the organisation of machine tool building. No other evidence for the existence of this decree has been traced and it is possible that the source has mis-dated a later measure.

The revival of the engineering industry took place from 1922 , but the growth of its component branches was uneven as the following table shows:

Machine building Production 1922/23 to 1926/27 as a Proportion of Pre-War Output*(per cent)

Table 2.I

Branch	1922/23	1923/24	1924/25	1925/26	1926/27
General Mc.Bdg. ⁺	27	37	47	83	125
Agricultural Mc.Bdg.	33	52	105	132	183
Ship building	12	24	25	47	71

*Active enterprises only. ⁺ industrial and transport machine building.

Source: Rozenfel'd & Klimenko, pp182,183.

The extent of the physical wear of equipment also varied between branches and between the different machine building trusts, while the level of capital utilisation showed similar variation:

Table 2.II

Value, Wear and Utilisation of Assets of the Four Leading Machine Building Trusts ,1st October 1925.

Trust	Value of assets m.r.	Value with account of depreciation(m.r.)	Depreciation (per cent)	Utilisation of assets* (per cent)
GOMZy	166.0	96.7	42	44.2
Lenmashtrest	115.0	80.3	31	56.8
YUMT	109.0	61.4	43	59.6
Gosshveimashina	25.6	18.9	26	70.0
Total	415.6	257.2	38	

* as a proportion of technically possible capacity.

GOMZy - Gosudarstvennoe ob'edinenie mashinostroitel'nykh zavodov, VSNKh SSSR.

YUMT - Yuzhnyi mashinostroitel'nyi trest, SNK UKSSR.

Gosshveimashina - Gosudarstvennyi trest po proizvodstvu i prodazhe shveinnykh mashin i chastei k nim , VSNKh SSSR.

Source: Industrializatsiya SSSR, 1926-1928, M., 1969, p176.

Even though there was up to 40-60 per cent spare capacity in the engineering

industry at the beginning of 1925/26 , calls for new construction and expansion became more insistent. One factor promoting these demands was that the rate of increase of production was so great that it threatened to leave the industry without reserves of capacity if no action were taken, e.g. Lenmashtrest alone increased its output in 1924/25 over the previous year by 77 per cent , and utilisation of capacity at the enterprises of the Trust which were then in service (eight out of twelve) rose from 48 per cent in the first quarter of 1924/25 to 77 per cent in the last quarter.¹ A very active role in drawing the attention of the Party and government to the need to devote more attention to the development of the engineering industry was played by F.E. Dzerzhinskii, in his capacity as chairman of the managing board of Glavmetall. In a report on the state and perspectives of the metal industry presented at the Plenum of the Party Central Committee in January 1925, Dzerzhinskii argued that the task of renewing the equipment of the engineering industry was one which had to be tackled without delay, and the Plenum resolved that urgent attention should be devoted to the question of developing the production of tractors, motor vehicles, rail transport equipment and ships.² This Plenum was a turning point for the development of the Soviet engineering industry and its conclusions were reinforced at the 14th Party Conference of April 1925 , which called for the elaboration of a three year plan for the construction of factories for the metal industry and acknowledged that such construction was a first priority task.³ But despite these positive measures, the problem of developing domestic machine tool building does not appear to have been raised at the Plenum or the Conference.

By the end of 1925 there were signs that machine tool building was beginning to revive , but at a slower pace than for other branches of industrial machine building such as the making of boilers and textile machinery. Soviet writers agree that the machine tool sector was very slow to develop and refer to the existence of spare machine tool capacity, the renewal of equipment during the war years and the complexity of the activity itself.⁴ Nevertheless, in 1924/25

¹ Khromov, S.S., *F.E. Dzerzhinskii vo glave metallopromyshlennosti*, M., 1966, pp 250-251;
 Chernov, A.S., *Metallopromyshlennost' SSSR*, M., 1925, p 18.

the 'Krasnyi Proletarii' factory built 202 machine tools⁵ and in June 1925 the im.Sverdlova works resumed operation as a specialised machine tool factory - the first in the Soviet Union.⁶ But the products of these factories and the production methods employed were were relatively primitive; the designs dated from the prewar years and the machines were built on an individual basis using a considerable amount of hand work. Concern over the widening gap between the level of technology in Russian industry and in the^{industrially} advanced capitalist countries led to the creation in early 1924 of a new organisation, specifically charged with introducing modern methods into Soviet industry, in particular the engineering industry. This was 'Orgametall' (aktsionernoe obshchestvo po ratsionalizatsiyu proizvodstva v tyazheloi promyshlennosti), founded on the personal initiative of E.M.Al'perovich, the former head of the Department of Metal of VSNKh, following a period spent studying the engineering industry of Germany. One of the tasks of this new organisation was the introduction into Soviet industry of the latest Western machine tools and tooling, but during the years 1925 to 1929 its main activity was projecting new machine building enterprises based on modern production technology.⁷

On 20th August 1925 the board of Glavmetall recommended the construction of fourteen new factories for general and agricultural engineering. These included a tractor works at Stalingrad, a wagon factory in Nizhnyi Tagil, a heavy machine building works in Sverdlovsk and eight factories for the production of agricultural machinery, including one in Rostov-on-Don.⁸ In December, a further heavy machine building works was added to the list - in Kramatorsk; and on 17th December 1925 these plans were approved by Gosplan.⁹ Meanwhile, in November, VSNKh approved the creation of a special institute for the planning of new engineering and metallurgical factories, Gipromez, which began work in February 1926. Thus, by the end of 1925 policy was undergoing a change, from one of the restoration of industry on its existing technical basis to a new policy of the reconstruction of industry on the basis of new technology. This transition marked the beginning of socialist industrialisation, a course adopted at the 14th Party Congress in December 1925, which took the

historic decision to,"carry out economic construction with the intention of transforming the USSR from a country importing machines and equipment into a country producing machines and equipment, in order that by this means the USSR, in a situation of capitalist encirclement, cannot be turned into an economic appendage of the capitalist world economy , but rather exist as an independent economic unit being built in a socialist way.."¹⁰

The Engineering Industry during the Reconstruction Period,1926-1929.

Before considering the development of machine tool building after 1926, it is necessary to briefly consider the context in which it was situated and the nature of the demand for machine tools which industry presented, in particular the engineering and metal working branches. The most striking feature of this period was the continuity with the pre-Revolution pattern of development and structure of the engineering industry ; a continuity which was to be challenged in the course of the period as demands for a radical break with the past became increasingly insistent and exerted an ever stronger influence on policy. The Soviet engineering industry at this time was characterised by the predominance of individual and small and medium batch production carried out in relatively unspecialised enterprises under the administrative control of a number of Trusts , the largest of which (GOMZy, Lenmashtrest, Mosmashtrest), were of a highly unspecialised nature. At the beginning of the period, production

2. Khromov, op cit, p184.; KPSS v rezolyutsiyakh i resheniyakh s"ezdov, konferentsii, plenumov TsK, Vol2, M., 1970, p150.

3. KPSS v rezolyutsiyakh i resheniyakh., op cit, p206.

4. Lebyachenko, p5.

5. ibid, p8.

6. Borisov & Vasil'ev, pp103-105.

7. 10 let Orgametall, 1924-1934, M., 1935, pp9-10; Stanki i Instrument, 1968, No7, p44.

8. Khromov, p245.

9. ibid, p247.

10. KPSS v rezolyutsiyakh i resheniyakh., op cit, 1953, Pt.2, p.75.

technology and the products built were basically those of the pre-War years, and the acute shortage of skilled technical specialists, especially those having a good knowledge of the latest Western practice, made it difficult to change this situation. During the period 1926-1929 capital investment in the engineering industry was devoted primarily to the reconstruction and expansion of existing enterprises, rather than the construction of new, and this practice tended to act against the adoption of new production technology and organisation. The structure of capital expenditure in general machine building was as follows:

Table 2.III
Capital Expenditure in General Machine Building, 1925/26 - 1927/28
(Per cent of total)

Category of capital expenditure	1925/26	1926/27	1927/28*
Expansion and reconstruction	47.9	54.8	60.0
New factories	23.3	10.1	17.6
Capital repair	23.7	17.6	13.0
Housing for new factories	5.1	17.5	9.4
Total	100.0	100.0	100.0

*From date of source must be provisional or planned expenditure

Source: Industrializatsiya SSSR, 1926-1928, op cit, p179. (From a VSNKh report of August 1928)

Analysis of the stock of machine tools installed during the years 1918 to 1928 provides substantial support for the view that there was no decisive break with pre-Revolutionary practice during the restoration and reconstruction periods.¹ Firstly, the branch structure of machine installations was very similar to the branch structure inherited from Tsarism. Before 1928, the largest number of installations was in the locomotive and wagon building branch; the branch with the largest machine tool stock before the Revolution. Other branches in which a relatively large number of machine tools was installed were agricultural

1. From the machine tool Census of 1932 - see Appendix 3 for details.

machine building, electric power equipment building and the production of industrial power equipment, all branches quite strongly developed before the Revolution and characterised by a predominance of individual and small batch production organisation. The degree of specialisation and automation of machine tools installed between 1918 and 1927 was almost identical to that of machines installed before 1917, as was the structure of labour skills associated with the machines installed. Significant changes in these indicators did not take place until 1929, when machine tools began to be installed on a large scale in new branches characterised by large-batch and mass production technology.

During the Reconstruction period there were two main forces which acted counter to the traditional, inherited structure and practice; firstly, the development of new branches of production and, secondly, the campaign for the rationalisation of production. The most significant new branches to be developed at this time were vehicle building and tractor production, two closely related activities which in the West had played a leading role in creating progressive production technology. The building of trucks was concentrated at the Moscow AMO factory, which built Fiat-type $1\frac{1}{2}$ ton vehicles on a small scale: only 698 units were built in 1928.¹ Tractor building was more highly developed than truck building before 1929. During the Restoration period a number of factories built tractors on a small scale, including the Khar'kov locomotive works, the tractor-building shop of which was partly equipped with machine tools from the former machine tool factory, 'Gerlyakh and Pul'st'.² From 1926/27 tractor building was concentrated at the 'Krasnyi Putilovets' factory in Leningrad, where modern progressive production technology was adopted for the building of the 'Fordson' 20 h.p. model. Much use was made of special fixtures and tooling and elements of mechanised flow-line assembly were introduced. But the relatively limited influence of these developments on the demand for machine tools is shown by the fact that of the total stock of machine tools installed in the automobile industry in April 1932, only 386 machines, or 7.9 per cent of the total, were installed

1. Makeenko, *op cit*, p188.

2. *ibid*, p175.

between 1918 and the end of 1928; and for the tractor industry, only 163 machines, or 4,3 per cent of a total of 4,890 units.¹ Furthermore, the machine tools installed in these branches were almost entirely imports.

The abolition of the universalism of the engineering industry inherited from Tsarism was not an easy process. The unspecialised nature of production was reinforced by the difficult economic conditions of the early years of Soviet power, when factories lacked sufficient regular orders to concentrate on a narrow range of products. The path adopted for overcoming this form of technical and economic backwardness was 'rationalisation'. The rationalisation movement in the Soviet Union owed much to the experience of the industrially advanced capitalist countries, in particular, Germany, where the theory and practice of rationalisation attained its highest level of development. In the United States the stress was placed on 'simplification' and the elimination of duplication in product ranges of firms and of diversity having no technical or economic justification. At the same time, the American development of flow production methods associated with Henry Ford, and of scientific management, exerted a considerable influence on European forms of rationalisation. In Germany, the rationalisation movement was more comprehensive and passed through two main stages: firstly, an initial post-War stage of 'negative' rationalisation, representing a process of making the best use of an over-expanded production base by closing down uneconomic enterprises, the scrapping of old buildings and equipment and the concentration of production of products at factories most suited to the making of each particular product and, secondly, when the initial spare capacity had been absorbed, rationalisation became a positive activity of introducing scientifically substantiated techniques and new technology.² In the Soviet Union, the rationalisation campaign followed closely that of Germany, passing through the same stages: the conservation policy and the closing down of small, poorly equipped enterprises was the Soviet equivalent of the

1. Calculated from, Oborudovanie metallobrabatyvayushchei promyshlennosti, M., 1935, vyp. 2, pp 130-131.

2. Brady, R.A., The rationalisation movement in German industry, California, 1933, p xii.

first stage of German rationalisation. By 1927 emphasis began to change in the direction indicated by the German movement. A Party Central Committee decree of 24th March, 1927, 'On the question of the Rationalisation of Production', stated that, "The improvement of technology and the organisation of production must take three main directions : i) the creation of new enterprises on the basis of the latest achievements in the realm of science and technology, ii) the fundamental reequipping of existing enterprises by way of the introduction of the best technical equipment and better organisation of labour, and iii) the provision of a number of practical measures with the ^{aim of} maximum utilisation of existing equipment and the reorganisation of production".¹ These practical measures, vigorously propagated by the workers of the People's Commissariat of Workers' and Peasants' Inspection (NK RKI), focused on the specialisation of enterprises, the reduction of product variety, the introduction of standardisation and, on the basis of the increased scale of production of homogeneous items achieved by these means, the development where possible of the technology of large-batch and mass production. These measures were essentially organisational in nature and did not necessarily involve capital investment on any scale : rationalisation was thus an appropriate method of raising the technological level of industry at a time when the 'regime of economy' was regarded as the primary means of financing industrialisation. But the introduction of progressive organisational and technological principles was no easy matter. The inherited organisational structure and production methods proved very difficult to alter and VSNKh, being responsible for current production, showed rather less enthusiasm for change than did NK RKI, which had no direct responsibility for plan fulfilment.

Some of the problems of modernising the engineering industry stemmed from the administrative structure of the industry during the reconstruction period. Responsibility for general planning of the metal industry, both the metallurgical and engineering sectors, was vested with Glavmetall of VSNKh USSR, which was also charged with exercising general leadership in accordance with directives issued by the Presidium of VSNKh. After the death of Dzerzhinsky in 1926, Glavmetall

1. KPSS v re olyutsiyakh i resheniyakh, op cit, 1970, Vol 3, p. 456.

was headed by V.I.Mezhlauk, previously its deputy chairman. In August 1928 Glavmetall was disbanded and machine building was placed under the control of a new organisation, Glavmashinstroi, the chairman of which became A.F.Tolokontsev, formerly the head of Voenprom, the body responsible for the activity of the four defence industry trusts.¹ While these administrations were responsible for overall policy for the engineering industry, direct control was exercised by a number of trusts, each of which united a series of enterprises. The trusts were responsible for the economic activity of their subordinate enterprises, and for technical policy and rationalisation. The trusts were very varied organisations; some were specialised by activity, eg. the Leningrad ship-building trust and Aviatrest, the latter uniting the factories of the aircraft industry, but the largest trusts were composed of widely differing enterprises, e.g. the Leningrad machine building trust (Lenmashtrest), ^{the ten factories of which in 1927/28} included the vast 'Krasnyi Putilovets' works, the 'Russkii Dizel' factory, the im.K.Marksa textile machinery factory and the im.Sverdlova machine tool factory.² This diversity hindered the realisation of specialisation of production and a consistent technical policy, as it frequently meant that factories of the same activity were located under a number of different trusts. The situation was further complicated by the fact that sales and supply were handled by separate organisations, the most important of which were Mashinosindikat, Metallokonventsia and Sel'mashkonventsia.³ Finally, the import of machinery was handled by a specialised organisation, 'Metalloimport', created at the end of 1926. A feature of most of these organisations was that many of the leading cadres were not Party members and wholehearted supporters of the Soviet regime, but engineers, technicians and administrators of the old order - bourgeois specialists, attracted to work for the economic restoration of Russia in the peculiar conditions of the New Economic Policy.

1. Torg.Prom.Gaz., 16-8-28.

2. Rozenfel'd & Chikhachev, p203. A detailed account of the trusts and their member factories is given by Makeenko, op cit, pp32-48.

3. Rozenfel'd & Chikhachev, p204.

A Policy for the Rationalisation of Machine Tool Building

Until the spring of 1926 there was no specialised body in the Soviet Union responsible for machine tool building. This was remedied by a decree of Glavmetall on March 4th, 1926, which called for the creation of a Section of Machine Tool Building attached to the Convention of Syndicates of the Metal Industry. This Section was given the tasks of, "working out and examining questions concerning needs for machine tools, examination and clarification of questions concerning the state of machine tool building in the USSR, questions of rationalisation of production, problems of standardisation of machine tools, and the specialisation of factories by type of machine tool, the allocation of orders and consideration of economic questions related to machine tool building".¹ The head of the Section was an engineer, M.F. Orentlikher. In April 1926 a similar section was organised with responsibility for the production of small tools and measuring instruments. But while the new Section had a wide-ranging brief, its powers were limited in so far as the syndicates did not have direct responsibility for the activity of the machine tool building factories.²

In May 1926 the first meeting on machine tool building was organised by Glavmetall, at which Orentlikher presented a report on the development and rationalisation of machine tool production. It was acknowledged that machine tool building represented one of the weakest links of the engineering industry, but also that the demands of reconstruction and of freeing Soviet industry from foreign dependence made the domestic production of machine tools a matter of considerable importance. At that time only four factories were building machine tools, 'Krasnyi Proletarii', im. Sverdlova, 'Dvigatel' Revolutsii' and the Kramatorsk works, the latter making metal-forming equipment. All four had been involved in this activity before the Revolution. An additional factory was to be built in Sverdlovsk, for the production of metal-forming equipment and metallurgical equipment for the Urals iron and steel industry - the future Uralmashzavod. Meanwhile, there was a very considerable discrepancy between the demand for

1. Byulleten' konventsii sindikatov metallicheskoj promyshlennosti, 1925/26, No 10-12,

p 50.
2. In June 1926 the Convention was replaced by 'Mashinosindikat', later known as VMTS.

machine tools and the ability of the domestic industry to fulfil it : it was estimated that in 1925/26 only 9.6 per cent of all needs would be met.¹ The producing factories were secured orders for 1½ to 2 years, a situation which Orentlikher considered highly favourable for the development of rationalisation, and which made it possible for the Convention to divert its efforts from trade to the reorganisation of production. The main lines of rationalisation of machine tool building had already been determined by the American and German industries, Orentlikher believed, and all that remained was to adopt similar policies in the Soviet industry. Firstly, the number of types and sizes of machine tools had to be limited; the desires of customers alone could not determine the product range, but account had to be taken of the interests of the producers of the machines. Secondly, factories had to be specialised so as to reduce the number of types and sizes built by each. Orentlikher referred to the fact that in the USA many factories produced only one type of machine tool, and in the recent past the German industry had begun to take the same path ; "Here", he added, "the situation of demand is such that we could restrict the number of types and sizes of machine tools to an extraordinary degree "², retaining ,however, the production of the necessary basic types. Clearly, in the Soviet Union, with such a small production base the possibilities of factory specialisation were very limited. The Section had drawn up a draft plan of specialisation which provided for the making of 17 different types in 40 sizes; of the basic types, three factories were to build lathes, two were to build planing machines, vertical and radial drilling machines were to be built by one factory only and milling machines by two factories. The maximum number of sizes to be built at one factory was twenty-five and the minimum, eight.³ At the time of the meeting the 'Krasnyi Proletarii' works was in fact building a total of eleven different types of machine tool⁴, although its output in 1925/26 was only 297 units.⁵ The basic principles of this draft plan were accepted by the meeting.

1. Orentlikher, M., "Ratsionalizatsiya stankostroeniya", *Sistema i organizatsiya*, 1926, No 4, p11. (This article appears to be Orentlikher's report to the May meeting)

2. *Ibid.*

3. *Ibid.*

4. *Torg. Prom. Gaz.*, 11-5-26.

5. Lebyachenko, p8.

A third path of rationalisation outlined by Orentlikher was the limitation of the number of sizes of machine tools of each type, the tipizatsiya of machines. Such reduction of sizes would facilitate the introduction of parts and components common to the different machines of a given type and such unification would permit the building of special machines on the basis of standard universal models. Orentlikher linked tipizatsiya with the process of raising the technical level of the machine tools built by Soviet factories, with the aim of securing more accurate machining so as to eliminate much of the hand fitting then characteristic of all branches of engineering. The final basic path of rationalisation was considered to be the normalisation of parts and materials; normalisation being defined as the adoption of logically established numbers, forms, and magnitudes of parts entering into machine tools and ^{of} the materials employed. Such normalisation was then being carried out by some factories individually, but efforts were not being coordinated. These four directions of rationalisation work would, it was believed, give the possibility of raising the size of batches of given types and sizes of machine tools built, with consequent cost savings. This set of fundamental principles of rationalisation was to be central to policy in the machine tool industry during the fifteen years from this first meeting in May 1926 to the War.

In discussing the problem of raising the technical level of Soviet machines, Orentlikher noted the possibility of entering into technical cooperation with foreign firms, and also mentioned that individual factories were engaged in discussions on cooperation. "However", he added, "one should not forget that one cannot simply transplant the production of a machine tool from a German to a Russian factory. Such an approach to the problem is impracticable, dead and schematic. In order to realise the building of a new type of machine tool one has to split it up into its separate parts and, with the aid of scientific and mathematical analysis, study the methods of making them at all stages." ¹ Again, this approach to the problem of copying foreign machines was to be restated on many occasions in subsequent years. The meeting of May 1926 thus played an important role in clarifying policy for the development of machine tool building.

Plans and Priorities

One of the central concerns of the Section of Machine Tool Building and Glavmetall during the years 1926 to 1929 was the elaboration of plans for the future development of machine tool building, this work being carried out within the wider context of the drawing up of a Five-year Plan for the development of the economy as a whole. Those responsible for planning machine tool building faced a number of extremely difficult problems, some of which stemmed from the very nature of the activity. The Party leadership accepted in general terms the need to develop the production of instruments of production and recognition of this fact was embodied in the resolutions of the Fifteenth Party Conference in the autumn of 1926: "Having in view the necessity of the organisation in our country of the production of instruments of production, with the aim of eliminating dependence on capitalist countries in a sector which is decisive for industrialisation, Conference places before the state and economic organs the task of the all-round development of machine building".² But acknowledgement of the leading role of the machine building industry in general terms was one thing; recognition of the crucial importance of the machine tool sector in particular was another. There were a number of good reasons why such recognition was not readily forthcoming. Firstly, the machine tool sector was a very small component of the engineering industry: before the Revolution, in 1912, it had accounted for only 0.8 per cent of total engineering output, in 1925/26 1.0 per cent,³ and even at the end of the First Five-year plan period, in 1932, only 2 per cent.⁴ For comparison, locomotive and wagon building accounted for 15.4 per cent of total output in 1925/26 and textile machine building, 5.7 per cent.⁵ Secondly, machinetools were very mundane and unromantic products compared with tractors, turbines or tanks, and it proved very difficult to mobilise public opinion in support of machine tool building. A Pravda editorial at the end of 1931 observed

1. Orentlikher, Sistema i organizatsiya, op cit, p12.

2. KPSS v resolyutsiyakh i resheniyakh., op cit, Vol2, p375.

3. Khromov, op cit, p324.

4. Stanki i Instrument, 1947, No11, p3.

5. Khromov, loc.cit.

that, " We devote little attention to this matter (machine tool building). The entire country knows about the new powerful turbines and blooming mills. Proletarian public opinion must turn its attention to the same degree to the problem of creating Soviet machine tools".¹

But the reasons for the relative neglect of machine tool building during the 1920s went deeper. Before the Revolution, machine tool building had not been a profitable activity except during the abnormal conditions of war, or when companies built relatively primitive machines to the order of the railway repair shops or the military authorities. Russian machines were generally employed for repair work or other auxiliary functions; basic production processes were supplied with imported equipment. During the Restoration and Reconstruction periods the same pattern applied, as the Soviet products were technically inferior to their German, British and American equivalents and relatively more expensive, because of the backward production technology and organisation employed. Furthermore, although a high proportion of demand was satisfied by imports, the absolute magnitude of these imports must have seemed rather insignificant to planners and managers alike. In 1925/26 imports of metal cutting machine tools represented a mere 4.1 per cent of total imports of machinery and equipment and 0.8 per cent of all imports. By 1927/28 machine tool imports had risen sharply, but still represented less than 9 per cent of machinery and equipment imports and 2.1 per cent of all imports.² For these reasons there does appear to have been a widespread view in the 1920s that machine tool building was not a ^{high} priority for Soviet industry, but a sector which could be tackled at a later date when conditions were more favourable. It was this position which was to be powerfully challenged in the years immediately preceding the First Five-year Plan.

Plans for the development of machine tool building required as a basis some estimation of the economy's needs during the plan period in terms of the quantity of machines demanded and the structure of these machines with respect to types and sizes. During the 1920s information about the existing stock of machine tools

1. Pravda, 17-12-31.

2. Calculated from *Vneshnyaya trgovlya SSSR za 1918-1940gg*, M., 1960, pp. 267 & 301.

was quite inadequate for making an accurate assessment of the specific requirements of each branch. No census of the machine tool stock was taken between 1908 and 1932, so that even the magnitude of the stock and its structure were only known approximately and, prior to 1929, there was no attempt to compile a balance of machinery for the economy, revealing needs and sources of supply for the plan period. The inadequacy of the data meant that estimates of the stock and future needs tended to be presented in highly aggregated value terms, providing considerable scope for error. Finally, the planners were faced with the problem of uncertainty over the general path and rate of economic development which characterised this period of Soviet history. Every decision to accelerate the construction of new factories in any branch of the engineering industry, or to increase the capacity of new or existing enterprises, led to a corresponding increase in the demand for machine tools, necessitating frequent revisions in the plans for the branch.

The first attempt to clarify the development of machine tool building over a five year period was made in 1926 by the Section of Machine Tool Building at, or shortly after, the May meeting. Needs for machine tools were estimated by a very crude procedure: the stock of machines in the metal industries in October 1924 was estimated to be valued in current prices at 198.5 million rubles, and the machines were considered to be on average fifty per cent worn. A ten year life for the machines was assumed, giving an annual replacement demand of 20 m.r. a year. In addition, machine tools to the value of 4-5 m.r. would be required annually for the expansion of existing factories and the construction of new, giving 24-25 m.r. a year, while the needs of other users would be met by an additional 20 per cent of this sum, giving a total annual demand of about 30 million rubles.¹ This total and the stock estimate included both metal cutting and metal forming machines. Thus no increase in the level of demand over the five years, 1925/26 to 1930/31, was foreseen, but rather the reverse, because needs in the final year were set at 28.8 m.r.. This demand was to be satisfied by making full use of the capacity of the three main enterprises, 'Krasnyi Proletarii'.

1. Orentlikher, *Byulleten' konventsii*, ..., op cit, p156.

im.Sverdlova and 'Dvigatel' Revolyutsii', giving 12 m.r. output in 1930/31, but further expansion of these factories was ruled out because of their 'obsolescence'. A further 5.6 m.r. worth of metal forming equipment would be produced by the Kramatorsk works in the Ukraine, while the remainder would be supplied by two new factories, each having 2,000 workers and giving an output of 5.6 m.r. a year. One of these new factories was to be built in Sverdlovsk and was to supply metal forming and metallurgical equipment (later to be known as Uralmashzavod), the other was to build metal cutting machines and be located in the South to supply machines to the railway workshops.¹

A second meeting on machine tool building was organised by Glavmetall at the beginning of March 1927. Once again, Grentlikher presented the main report on the development of the branch, but the meeting was opened by the chairman of Glavmetall, V.I.Mezhlauk. Before the War, Mezhlauk claimed, "machine tool building in essence did not exist" , but, " in order to build machines it is necessary , above all, to master machine tool building, and therefore the development of machine tool building at Soviet factories is one of the most important tasks of the metal industry".² Meanwhile, imports of machinery were greater than before the War . However, initial plans for 1927/28 then provided for a reduction of machine tool imports compared with the level of 1926/27; an intention which Mezhlauk considered incorrect, because, "In order to free ourselves from dependence in the future and establish our own production, we should , on the contrary, import significantly more equipment for the first two or three years". This principle was to be restated on a number of occasions in the following three years and became central to the industrialisation strategy , but the problem of timing remained: during which 'two or three years' were machine tool imports to rise? The immediate task before the machine tool builders ,in Mezhlauk's view, was to sharply reduce the extraordinarily high cost of Soviet machines by means of the specialisation of factories, the transition to batch and mass production and the tipizatsiya of machine tools. In order to

1. ibid.

2. Torg.Prom.Gaz., 3-3-27.

secure such a cost reduction and to raise the technical level of the machines built, it was essential, Mezhlauk believed, to forbid the organisation of machine tool building at enterprises which had no previous experience of this activity ; in recent times there had been a tendency for many factories to build machine tools to meet their own needs. In effect, this was a call for the restriction of machine tool building to those factories which had undertaken it before the Revolution ; a plea for continuity which belied Mezhlauk's earlier claim that machine tool building had been non-existent at that time.

In his report to the meeting , Orentlikher restated his views on the need for rationalisation and also stressed the importance of creating a force of Soviet design personnel, but his main concern was the plan for the five-year period, 1927/28 -1931/32. The plan as seen in March 1927 represented a slightly ammended version of that discussed in the previous year. Needs for the five years again totaled 150 m.r., but now a rising trend of demand was foreseen, from 24 m.r. in 1927/28 to 36 m.r. in 1931/32.¹ For metal cutting machines ,needs were forecast to rise from almost 18m.r. in 1927/28 to 27 m.r. in the terminal year, compared with a planned production of 6.8 m.r. and 19.2 m.r. respectively. In the final year 71.1 per cent of demand would be satisfied from domestic production. Total output in the final year would be 28.2 m.r., composed of 11.5 m.r. from the three main factories, 5.6 m.r. from Kramatorsk, 4.9 m.r. from a number of local factories and 6.2 m.r. from two new factories. The two new combined factories were still to be built in Sverdlovsk and the South ,but their/capacity in 1931/32 was to be 6.2 m.r., compared with the 11.2 m.r. in 1930/31 outlined in the previous year. Fulfilment of these aims would require capital expenditure totalling 36.6 m.r. , including 11.2 m.r. for reconstructing the three main factories and a further 15.5 m.r. for building the two new works. But this capital investment was to decline over the five year period - 9.7 m.r. in 1927/28, 9.8 m.r. in 1928/29, 8.1 m.r. in 1929/30, 5.8 m.r. in 1930/31, and 3.2 m.r. in the final year.² This 'diminishing curve' of investment outlays reflected the

1. *ibid.*; and, Orentlikher, M., "Sostoyanie i perspektivy stankostroeniya", *Metall*, 1927, no 6, pp 74-77. For details of the plan and other variants, see pp. 448-457 below

2. *Torg. Prom. Gaz.*, 3-3-27.

thinking embodied in the VSNKh OSVOK draft of the Five-Year Plan of 1926, but not that of VSNKh in the spring of 1927, when its second draft was under preparation.¹ Unfortunately, details of the investment plans for the machine tool industry later in 1927 and in 1928 are not known, so that it is not possible to say whether this 'diminishing curve' of investment was later corrected. The whole plan for machine tool building reflected a very modest and short-term conception of reconstruction of the economy: the rate of growth of demand for machine tools was to fall over the five years, from ^a12.8 per cent in 1928/29 compared with 1927/28, to an 8.9 per cent increase in 1931/32 compared with 1930/31.² while the short-run increase in imports which Mezhlauk had referred to amounted to a mere half million rubles (from 11.2 m.r. metal cutting machine tool imports (excluding customs duty) in 1927/28, to a maximum of 11.72 m.r. in 1929/30).³ This particular variant of the Five-Year Plan for machine tool building was still basically in force in May 1928, when Glavmetall presented a report on the development of heavy engineering to the Presidium of Gosplan.⁴

The rather complacent approach to the problem of developing the domestic machine tool industry during 1926 and 1927 may well have been conditioned by the unusually favourable situation with regard to machine tool imports. In April 1926 a major trade agreement was signed under which the German government agreed to guarantee sixty per cent of payments for goods supplied to the USSR to a total sum of 300 million marks. Over half this credit was used for purchasing machinery and equipment, including a considerable number of machine tools. This credit led to a sudden, very marked increase in machine tool imports, from 6.3 million rubles in 1925/26 to 19.4 m.r. in 1926/27 and 20.0 m.r. in 1927/28.⁵ The placing of orders under this agreement ended in the autumn of 1927; the agreement was not renewed, and machine tool imports fell in 1929. The ease with which machine tools could be imported at this time must have had some influence on priorities within VSNKh and industry at large.

1. see Carr, E.H.; Davies, R.W., Foundations of a planned economy, Vol 1, 1974, pb. edn., pp. 902-915
 2. see p. 448, calculated from 'Variant II'.
 3. see p. 448 (imports calculated - needs minus production).
 4. Torg. Prom. Gaz., 11-5-28.
 5. Vneshnyaya torgovlya SSSR za 1918-1940gg, op cit, p269.

In the autumn of 1927 the first successes of rationalisation were reported. A review of the achievements of the first decade of Soviet power presented a very favourable view. Production methods had 'significantly improved' since before the War, with increasing use of gauges and templates to give interchangeable parts.¹ The 'Krasnyi Proletarii' factory pioneered the use of jigs and fixtures in Soviet machine tool building and created a bureau of fixtures in 1925, consisting of one man, which quickly grew as the factory introduced the production of diesel engines on a batch basis.² Batch production of diesel engines was achieved in 1929, with technical assistance from the German firm of 'Otto Deutz' and this experience was later applied to machine tool building.³ Before the Revolution the leading figure in the machine shop had been the mark-out man, who marked out the work for machining and determined the accuracy of the parts. But progress was slow; British engineers visiting the factory in 1931 commented on the "notable absence of jigs, involving much marking out".⁴ In January 1927, the im.Sverdlova factory proudly announced that it had achieved interchangeable parts production in the building of a 'new' lathe (in fact based on a pre-War design).⁵ The 'Krasnyi Proletarii' factory also carried out pioneering work on machine tool standardisation. Mosmashtrest, to which the factory was subordinated, organised a standardisation bureau on the site of the enterprise, in view of its experience in this field before the Revolution.⁶ By the autumn of 1927 work was being carried out on the establishment of a systematic nomenclature of machine tools and the determination of standard sizes, while the problem of drawing up acceptance conditions for machine tools was also receiving attention.⁷ Successes were also claimed in developing batch production: individual types were being built in batches of from fifty to one hundred in 1926/27.⁸

1. Torg. Prom. Gaz., 7-10-27.

2. Ostrovskii, Z. I., Ot Bromleya k 'Krasnomu Proletariyu', M., 1937, p6.

3. Slavnye traditsii, op cit, p186; Lebyachenko, p8.

4. Machinery, Vol 38, 16-7-31, p502.

5. Torg. Prom. Gaz., 22-1-27.

6. Omarovskii, op cit, p167.

7. Torg. Prom. Gaz., 7-10-27.

8. Ibid; see also Orentlikher, M., "Stankostroeniya", Vestnik Inzhenerov, 1927, No12, p543.

From the summer of 1927 industrialisation policy began to be increasingly influenced by military considerations. The Combined Plenum of the Central Committee and the Central Control Committee, in August 1927, issued a decree on the economic directives for 1927/28, which placed great emphasis on the threatening international situation following the raid on the Arcos office in London and the subsequent breach of relations with Britain. This was followed in October by a Combined Plenum on the directives for the Five-year Plan, which again stressed the possibility of capitalist military intervention and the need to prepare for it. Links with capitalist countries had to be directed towards strengthening the economic independence of the Soviet Union and the acceleration of industrialisation. This theme was taken up again at the Fifteenth Party Congress in December 1927, notably by Voroshilov.² In February of the following year, Mezhlauk, speaking at the Eighth All-Union Congress of Metal Workers, declared, "What tasks stand before the metal industry in 1927/28 and in the coming years? The basic task is the securing for the country of an adequate military capacity. With respect to the economy, the Soviet Union must become independent from foreign capital". There had been great successes, but, "...many machines and machine tools are copies of obsolete designs; output satisfies only an insignificant proportion of needs and must be developed. The view exists that to undertake machine tool building is unprofitable and irrational. This is not true. Machine tool building must be undertaken: without it there can be no independence from foreign capital".³ At a previous congress of metal workers in October of the previous year, Mezhlauk had found it necessary to explain why this unprofitable production had to be undertaken: "When we take the path of producing means of production, we always bear in mind that this is unprofitable production, but one which we have to have. Machine tool building is in this category. Although this most important of branches is not very profitable in terms of its contribution to industrial accumulation, the establishment of machine tool building is important, because he who masters machine tool building masters the entire metal industry..".⁴ But

1. KPSS v razvitiye i resheniyakh..., op cit, Vol 2, pp507 - 512.

2. see Carr, E.H.; Davies, R.W., op cit, pp454-460.

3. Torg. Prom. Gaz., 19-2-28.

4. Torg. Prom. Gaz., 11-10-27.

these attempts to convince the sceptics and win the metal workers' Union to the cause of accelerating the development of Soviet machine tool building do not appear to have had any immediate impact.

It was not until the autumn of 1928 that the question of machine tool building began to receive serious attention, but in the preceding months more general problems of technical policy for the engineering industry were publicly aired and conservative attitudes vigorously challenged. One central issue, which was debated in the summer of 1928, was that of the type of machine building factories to be built in the Soviet Union. Strong views had been expressed earlier; an editorial in the industrial newspaper Torgovo-Promyshlennaya Gazeta, for example, in May 1927, pointed out that the objective factors promoting universalism of enterprises no longer existed and that the aim should be to specialise factories on a limited range of products allowing large-batch and mass production and the use of specialised machinery.¹ This policy was vigorously advocated by NK RKI, which consistently coupled demands for better use of existing capacity with calls for the application of large-batch and continuous-flow methods. At this time the merits of the Ford system of continuous-flow organisation were being enthusiastically championed: 'Fordizma' was the only path for the Soviet engineering industry. In May 1928 Mezhlauk called for the specialisation of factories, and the provision of centralised preparatory factories (foundries and forges). He also reiterated a call he had made in the previous month for the reorganisation of Glavmetall, to provide a more specialised administration for the machine building industry.² This appears to have been the starting point of a long controversy on the specialisation of engineering enterprises in which representatives of all interested bodies participated - VSNKh, Glavmetall, Orgametall, NK RKI, and representatives of the trusts and factories.³ Most participants were agreed that the new factories then under construction or being projected were not examples of progressive specialised production, being marked by a tendency to revert to the universalism so long characteristic of Russian machine building. The Rostov agricultural machinery

1. Torg. Prom. Gaz., 12-5-27.
2. Torg. Prom. Gaz., 8-5-28; and 15-4-28.

works came under especially strong attack on these grounds. The main targets of criticism were Glavmetall and Giprometz, both of which seemed to be particularly disposed towards the construction of large, 'closed combines'.⁴ The general conclusion appears to have been that new factories should be specialised on specific products, that there should be centralised preparatory works, and active cooperation between enterprises. Such organisation would allow the adoption of large-batch and mass production technology with the use of more specialised machinery than the general-purpose equipment then predominating in the engineering industry. This conclusion was backed by the outcome of a simultaneous debate on the choice of textile machinery for Soviet industry, in which the advocates of smaller scale, less mechanised production were defeated.⁵

The call for specialisation and the adoption of large-batch production was made even more strongly by Kuibyshev at the end of August 1928 at the Third Plenum of the Party Central Control Commission. A rationalised enterprise was defined as one which undertook the mass production, on a continuous-flow basis, of products standardised by quality and size. But Kuibyshev conceded that results to date had not been impressive⁶; a view forcefully expressed by M. Kaganovich in his report to the Plenum on behalf of NK RKI. Kaganovich's speech amounted to a condemnation of Glavmetall for its alleged inactivity in carrying out rationalisation. Turning to the future, Kaganovich asserted that the basic line of rationalisation during the coming Five-year Plan period had to be attention to, " . old, existing enterprises, which for some time will play a dominant role in our economy", but, at the same time, rationalisation had to be based on new methods of production, otherwise there was, " a danger that the Five-year Plan will hold back the rate of growth of our industry".⁷ This position of the NK RKI was to have considerable impact on the future development of the machine tool industry.

3. This controversy is discussed below, Ch. 5.

4. Torg. Prom. Gaz., 15-6-28.

5. Torg. Prom. Gaz., 16-8-28.

6. Torg. Prom. Gaz., 29-8-28.

7. Torg. Prom. Gaz., 30-8-28.

The Break with the Past - Machine Tool Building in 1928/29.

In the economic year 1927/28, Soviet factories built metal cutting machine tools to the value of 6.4 million rubles, compared with 3.3 million rubles output in 1913 from the factories of the old Russian empire. In terms of the number of units built, output reached 2,000 machine tools, 450 of which were built by the 'Krasnyi Proletarii' factory.¹ In 1912 domestic production had accounted for 19 per cent of total sales: in 1927/28 the proportion was exactly the same.² About a dozen factories were building machine tools on a more or less regular basis; they were all subordinated to different trusts and all built a range of other items of machinery. There was thus no unified machine tool industry at the time when the First Five-year Plan was taking its final form.

In May 1928, in a report to the Presidium of Gosplan on the future of the heavy engineering industry, Glavmetall had presented final year targets for the Five-year Plan of machine tool building identical to those outlined in the previous year.³ It is not known whether the new versions of the Five-year Plan drawn up by VSNKh in April and August 1928⁴ led to any changes in the intentions with regard to machine tool building, but by the end of October it was clear that plans had been revised. At the end of the month, the permanent planning conference of VSNKh adopted a new variant of the control figures for the Five-year Plan providing for increased capital investment. Two-thirds of the additional investment was to be directed to the engineering industry under Glavmashinstroi, including 140 m.r. for general machine building, a category which included machine tool building. It was now proposed to build four small machine tool factories in the year 1930-31 and, possibly, a further factory in 1931-32.⁵ In November a conference of workers of machine tool building factories was held in Moscow to discuss the future development of the branch. Unfortunately, no details of this conference have been traced, apart from the fact that great emphasis was placed on the need to carefully choose the new designs to be built at each factory.⁶

1. *Sotsialisticheskoe stroitel'stvo SSSR*, M., 1936, p.156; Lebyachenko, *op cit*, p.8.

2. see Table 2.IV, p.42.

3. *Torg.Prom.Gaz.*, 11-5-28.

4. see Carr, E.H.; Davies, R.W., *op cit*, pp925-933.

Production and Imports of Metal Cutting Machine Tools

1924/25 - 1928/29

Year	Production ('000r.) (1)	Imports ('000r.)		Domestic Production as a proportion of total sales (%) (4)
		Including duty (2)	Excluding duty (3)	
1924/25	(1,040)	6,037	4,312	14.7 /19.4/
1925/26	1,950	8,860	6,329	18.0 /23.6/
1926/27	3,900	27,200	19,428	12.5 /16.7/
1927/28	6,400	28,060	20,045	18.6 /24.2/
1928/29	10,400	(25,095)	(17,925)	29.3 /36.7/

(..) Estimate

Sources

- (1) 1924/25 - Estimated. Total output of metal cutting and metal forming machine tools in 1924/25 was 1.3m.r. (Aizenshtadt & Chikhachev, p163). The proportion of cutting machines in the total output of 1925/26 (2.5m.r., ibid) was 78 per cent, and this is assumed to apply to 1924/25.
1925/26, 26/27, 27/28 - Aralov & Shatkhan, p141 (Prices of corresponding year)
1928/29 - ZaInd., 19-10-32 (marketed output in 1926/27 prices)
- (2) Calculated from Vneshnyaya trgovlya SSSR za 1918-1940gg., M., 1960, pp204-301. Data of source are translated into prices of corresponding years by a coefficient of 3.4851 (ibid, p9) to give column (3). According to Aralov & Shatkhan, p140, customs duty and various necessary commercial expenses were equivalent to 40 per cent of the value of machine tool imports at this time. Therefore, col.(2) equals col.(3), plus 40 per cent. Data presented are very similar to those given in Aralov & Shatkhan, p141.
1928/29 - source gives Oct.-Dec. 1928 and 1929 imports; 1928/29 est. therefore obtained from Oct.-Dec. 1928 total, plus three-quarters of 1929 total.
- (3) See (2).
- (4) Total sales taken as production (1), plus imports including duty (2).
Proportion of sales with imports excluding duty shown in brackets, /.../.

By the end of December 1929, VSNKh had completed the elaboration of its Five-year Plan for the engineering industry. Total marketed output of the industry was to increase by 3.6 times over the five years and costs were to be cut by no less than 38 per cent.⁷ Reporting on this plan to the Presidium of VSNKh, Glavmashinstroi called for wide-ranging rationalisation of production processes and the deepening of specialisation. All basic types of machine building were to make the transition to batch and mass production, with the adoption of the principles of continuous-flow organisation. The principles of specialisation of production were to be extended to the building of machine tools: each enterprise was to have a fixed, comparatively narrow, specification. In order to attain this end, besides the four main factories (including the Kramatorsk works), fifteen small factories were to develop machine tool building on the basis of strict specialisation by type of product. Furthermore, the preparatory stages of production were to be concentrated at separate, specialised factories.⁸ This Five-year Plan for the engineering industry was reported to a Gosplan conference on machine building at the beginning of January 1929 by A.A. Milyukov, the head of the production section of Glavmashinstroi. As in October, the Plan provided for the construction of five new factories, each with a capacity of 4-5 million rubles output.⁹ The planners of Gosplan had never previously acknowledged the existence of machine tool building in any of their Control Figures: it was for them merely a component of a broader category, general machine building, which in turn received very little attention.¹⁰

On 25th January 1929, the Presidium of VSNKh acknowledged the necessity of creating an All-Union Trust of Medium Machine Tool Building and, with this aim, proposed the transfer to the control of VSNKh of the 'Krasnyi Proletarii' factory of Mosmashtrest and the 'Dvigatel' Revolyutsii' factory of Nizhnii-Novgorod. These two enterprises were to be combined with the im. Sverdlova factory of Leningrad.¹¹ This important decision indicated a mounting concern for machine

5. *Torg. Prom. Gaz.*, 27-10-28.

6. Kas'yanenko, V.I., *Zavoevanie ekonomicheskoi nezavisimosti SSSR (1917-1940 gg.)*, M., 1972, p.95.

7. *Torg. Prom. Gaz.*, 28-12-28.

8. *Ibid.*

9. *Ek. Zhizn'*, 4-1-29.

tool building on the part of VSNKh ,although the new trust was not in fact created until October. Further evidence of concern was provided by a decision of the VSNKh Presidium to draw up a balance of equipment for the economy, in order to obtain an accurate account of the needs for new machinery and the scale of imports and domestic production.¹²

Early in April 1929, the leading members of Glavmashinstroi discussed the future of machine tool building and the creation of the new trust. The main report was presented by V.F.Oborin. He revealed that only 24 types and sizes of machine tools were then being built in Soviet factories and, according to the Five-year Plan, the total was to be raised to fifty. But, he stressed, "It will be possible to develop our production with the maximum rapidity only with a reduction of the product range".¹³ At that time, he continued, production was concentrated at four main factories (including the making of forming machines at Kramatorsk), two 'numbered' factories (i.e. military works; in this case, the Tula and Izhevsk arms factories), and six small local factories. This compared with 350 machine tool building enterprises in Germany. Turning to the future, Oborin expressed the opinion that successful development and, in particular, solution of the problem of designing new machines, required the conclusion of technical assistance agreements with foreign firms. At this meeting, representatives of Moscow SNKh, Mosmashtrest and Lenmashtrest attacked the proposed new specialised trust on the grounds that it was "an untimely reorganisation"; an understandable response to the threatened loss of one of their members. The chairman of Glavmashinstroi, A.F.Tolokontsev, in turn charged with trusts with devoting very little attention to machine tool building, and the meeting decided to proceed with the new organisation, which was to initially include three factories and start operation on 1st October. It was also decided that three months would be given before the location of new machine tool factories was finalised.

10. This even applied to the 1929/30 Control Figures, published in 1930, see Kontrol'nye tsifry narodnogo khozyaistva SSSR na 1929/30 god, M., 1930, p84.

11. Torg. Prom. Gaz., 26-1-29.

12. Torg. Prom. Gaz., 27-1-29.

13. Torg. Prom. Gaz., 14-4-29.

Events now gathered pace as the Five-year Plan neared its final approval by the Sixteenth Party Conference at the end of April. On 23rd April, Sovnarkom approved the 'optimal' variant of the Plan, but in doing so it called on Gosplan and VSNKh to further examine the question of stepping up the intended rate of development of machine tool building.¹ The decree of the Fifth Plenum of VSNKh on the Plan, published the following day, for the first time put machine tool building in first place in its section on the engineering industry. It stated that; "In the development of machine building it is necessary to devote special attention to machine tool building, striving for significantly increased production compared with that projected in the control figures of the five-year plan of industry. In order to achieve this it is necessary to take organisational measures for separating machine tool building into a special organisation, and to review the title list of capital work to secure a more rapid development of the production of machine tools."² On the same day, Kuibyshev reported on the Five-year Plan at the Sixteenth Conference and noted that over the five years only forty per cent of the demand for machine tools would be satisfied by domestic production. This point was taken up by a speaker in the discussion, Kadatskii, from Leningrad, who observed that, "During recent years we have spoken a great deal about machine tool building, but it must be admitted that during these years we have in fact done hardly anything in the field of complex and precision machine tool building"; and went on to criticise the inadequacy of the provisions of the Plan for the development of the industry.⁴ The resolutions of the Conference made no specific reference to machine tool building. On 29th April the Conference approved the optimal plan, the three volumes of which were published by the end of May.⁵

The Plan itself, as approved by the Sixteenth Conference gave no indication of either needs for machine tools, or the intended scale of production. It did, however, stress the vital importance of machine tool building; "The development and success of machine building is impossible without the preliminary organisation of a corresponding volume of production of metal and wood-working machine tools."

1. Torg. Prom. Gaz., 8-5-29.

2. Torg. Prom. Gaz., 24-4-29.

3. Shestnadtsataya konferentsiya VKP(b), sten. otchet, M., 1962, p64.

4. Ibid, p156.

5. The plan was approved by the Fifth Union Congress of Soviets on 28th May.

Economic and technical progress of any machine building is directly dependent on the corresponding equipment - machine tools and tooling. Hence, the leading role of machine tool building and tooling is evident.¹ While avoiding specific targets, the plan did set out broad policy guidelines. Soviet machine tool building had to be raised to a level adequate to meet the demand for the most widely used machines, but the building of special machine tools could be postponed to the following five-year plan period, except for very limited production with the aim of gaining experience.² On the question of the scale of machine tool building factories and their specialisation, the Plan favoured a cautious approach: "The experience of German and American factories shows that the amalgamation of enterprises is not a fact predetermining the best results in machine tool building. In view of the diversity of types and sizes, one needs to show great caution in carrying out specialisation".³ The three main factories were to be strengthened and specialised on the production of the most common types and sizes, a number of existing smaller factories were to be reconstructed and specialised, and two or three new factories were to be built. A sum of 25 million rubles was allocated for the construction of new factories over the five-year period.⁴ According to the title list of construction projects included in the plan, one new factory was to be built in Moscow at a cost of 15 m.r., work beginning in 1929/30 and ending in the final year of the Plan; a second was to be built in Khar'kov at a cost of 10 m.r., for construction during the years 1930/31 to 1932/33; and a possible third factory was to be built in the Urals at a cost of 10.5 m.r.⁵ This was the 'optimal' Five-year Plan of machine tool building, but it was out of date by the time it left the printers a new plan had been drawn up, substantially revising all previous programmes for the development of Soviet machine tool building.

In response to the decree of Sovnarkom, Glavmashinstroi met early in May and discussed measures for accelerating the development of machine tool building. It is known that this meeting resolved to begin the construction of two new factories in 1929/30, for which 7 m.r. was allocated, and to carry out reconstruction work at existing enterprises to the extent of 5 m.r..⁶ But it was probably at this

meeting that revisions were made to the Plan for machine tool needs and output over the five years.⁷ Previously, VSNKh had established that machine tool needs over the five years would total 152 m.r.; now a final year target of 84 m.r. was fixed, implying a total over five years of about 300 m.r..⁸ It was foreseen that 62 per cent of the final year demand would be satisfied from domestic production, i.e., output in 1932/33 would be 53 m.r., 22.5 m.r. of which would be given by the three main factories. During the five years, five new factories would be built.⁹ This new plan thus represented a considerable change of intentions compared with the variant in force only twelve months earlier. Two factors were probably responsible for VSNKh's change of view. Firstly, it appears that the findings of the commission which had been compiling a balance of machinery and equipment were now available. At the Fifth Congress of Soviets later in May, Kuibyshev referred to this balance and claimed that machine tool needs over the five years would be 425 m.r., 175 m.r. (or 41 per cent) of which had to be built by Soviet producers. These totals evidently referred to both metal cutting and forming machines.¹⁰ Secondly, machine tool building was being subjected to a major investigation by NK RKI, the first results of which were published on 19th May.

The State of Machine Tool Building in the Spring of 1929 : the NK RKI Survey.

Before considering the findings of the NK RKI survey, it is necessary to briefly look at the enterprises engaged in machine tool building at the beginning of 1929: these enterprises were to form the core of the industry during the First Five-year Plan period. The leading factory, 'Krasnyi Proletarii' has already been mentioned, but this was by no means a specialised machine tool factory. In 1926/27 45 per cent of its output took the form of machine tools; in 1927/28, 65.6 per cent.¹¹ The main secondary activity was the building of diesel engines, and according to a plan of reconstruction of the factory adopted

1. Pyatiletnii plan narodno-khozyaistvennogo stroitel'stva SSSR, 3rd edn., M., 1930, Vol. 2, pt. 1, p156.

2. ibid, p157.

3. ibid., p159.

4. ibid., Vol. 1, p46.

5. ibid, Vol. 3, Appendix: Ob'ekty novogo stroitel'stva gosudarstvennoi promyshlennosti na pyatiletie, pp10, 21. 27.

in October 1927, this activity was to be retained and expanded over the five years, with technical assistance from the German &Deutz' firm.¹² The product range in 1927/28 included lathes, shaping, planing, drilling, slotting and threading machines. From about 1929 the main product became the 'TN' lathe, a slightly modified design of 1915-16. The only fully specialised factory was the im.Sverdlova works of Leningrad. This factory took a number of years to restore production after its period of conservation. There was an acute shortage of skilled workers, engineers and designers; equipment was old and worn, and the level of work organisation was very low. In 1928/29 output reached 300 units, including shaping machines, lathes, Cincinnati-type tool sharpening machines and a few 'Fortuna'-type cylindrical grinding machines. The lathes and shaping machines were of old 'Phoenix' designs, but in 1928 the factory began to introduce a new lathe, the 'TV', based on a design of the German firm, 'Braun'. This model, characterised by a quite excessive degree of universalism (88 different feed rates), was to be the basic product throughout the First Five-year Plan period.¹³ The third main factory, 'Dvigatel' Revolyutsii', built diesel engines as its main product, machine tools accounting for 35 per cent of its output in 1927/28.¹⁴ This factory specialised in heavy machine tool building, its products being used by the locomotive and wagon building industry. Together, these three factories built 693 units in 1927/28 and 1,075 in 1928/29.¹⁵

From about 1925 the number of machine tool building factories began to gradually increase. In the Ukraine, the Odessa imeni Lenina factory began to

6. Torg.Prom.Gaz., 12-5-29.

7. Ek.Zhizn', 19-5-29 refers to recent changes in the Plan; Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, M., 1930, p173 refers to a Plan revision in May 1929.

8. Sotsialisticheskaya ratsionalizatsiya, op cit, p173; Torg.Prom.Gaz., 11-5-29 gives 84m.

9. Ek.Zhizn', 19-5-29.

10. Vs"ezd Sovetov, (sten.otchet), M., 1929, Byulleten' 9, p8.

11. Aizenshtadt & Chikhachev, p172.

12. ibid., p168.

13. Borisov & Vasil'ev, op cit, pp105-106; 15 let bor'by za sovetskoe mashinostroenie, L.-M., 1932, p46.

14. Ek.Zhizn', 19-5-29.

15. 'Krasnyi Proletarii' built 450 units in 1927/28 and 607 in 1928/29; im.Sverdlova, 157 and 299 respectively, and 'Dvigatel' Revolyutsii' 86 and 169 - Lebyachenko, op cit, pp.8-13; 20; Ek.zhizn', 19.4.29 (for 'D.R.', 1927/28 only).

build machine tools in 1925. Founded in 1862 as the 'Bellino-Fenderikh' company, this works was engaged in ship repair work and the making of ship components before the Revolution. It was in conservation from 1922 to 1924, when it was reopened as a general engineering works under Odessa Metallotrest. Originally, machine tools were built to individual order, giving rise to a proliferation of types built, but from 1927/28 measures were taken to reduce the product range so that in 1928/29 only lathes, drilling, planing and threading machines were produced.¹ In 1927/28 machine tools accounted for 65 per cent of total output.² At this time the designs were old and the factory was ill-equipped and in need of reconstruction.

In 1927 machine tool building was started at the Samara (later, Kuibyshev) factory, 'Imeni Soyuz Ts.K. Mashinostroeniya'. This works began life as a small repair shop in 1874, becoming a general engineering factory in 1895, when it built locomobiles, boilers and other industrial equipment. In 1911 it ceased operation and its equipment was removed. During the Civil War the shell of the works was taken over by a machinery repair shop evacuated from the front and this developed into a repair shop for local industry. In 1927 the first orders for machine tools were accepted, although there was no previous experience of this activity. Very simple lathes and drilling machines were built, alongside a range of other engineering products:³ machine tools accounted for 37.5 per cent of total output in 1927/28.⁴ While the 'TsK Mashinostroeniya' works had no previous experience of machine tool building, this was not the case with the 'Samotochka' factory of Moscow, which began building machine tools in 1926. This was formerly the 'Yu.Shtolle' factory, founded in 1898, which built machine tools from 1910, supplying lathes and some turret lathes to military departments. This indicates quite a high technical culture and explains why, after the Revolution, activity was resumed under Mospoligraph, repairing printing machinery. It was then transferred to Mosredprom and began machine tool building, from the start 'Samotochka' built shaping machines and this was to remain the speciality of the

1. Aizenshtadt & Chikhachev, pp180-181; Lebyachenko, pp20-21.

2. Ek.Zhizn', 19-5-29.

3. Lebyachenko, pp27-28;

4. Ek.Zhizn', 19-5-29.

factory for several years. In 1927/28 machine tools represented 24.2 per cent of output¹; the main product of the factory continued to be machinery for the paper and printing industry. Machine tool building was also undertaken on a small scale by the 'Komsomolets' factory and technical school in Egor'ev (Moscow oblast'). This factory-school was founded in 1909 by the 'Bardygin' firm for training technicians. During the War it built some machine tools for military production and this activity was resumed in 1925, when 32 shaping machines were built for the market. Machine tool building was regarded as a means of improving the financial position of the school. In 1927 a new lathe was introduced, distinguished by its single pulley and gearbox drive at a time when the more primitive stepped pulley drive was typical of all Soviet-produced machines. A certain degree of universalism was retained as a deliberate policy in the interests of providing a range of work for teaching purposes.² The final civilian factory of any importance building machine tools on a regular basis at this time was the 'Kommunar' works of Lubny in the Ukraine. This factory, previously engaged in repair work, began to build simple lathes from 1926; and lathe building was to remain the main activity until the War.³

Two important machine tool building factories were located in the military sector under the gun and machine gun trust, 'RUZh', created in 1926. During the second half of the 1920s the Tula arms factory, which had a very long history of machine tool building experience, produced a simple milling machine, model 'TG-1', with hand-feed.⁴ This was the only milling machine to be built on a regular basis in the Soviet Union before the First Five-year Plan period. The Izhevsk gun making and steel works of the Udmurt Autonomous Republic began machine tool building in about 1928, making a simple lathe of the German, 'Loewe', type, which became known as the 'RUZh' lathe.⁵ In 1927/28 machine tools accounted for only 10 per cent of the total output of this factory.⁶

1. Ek. Zhizn', 19-5-29.

2. Lebyachenko, pp 28-31.

3. Ibid, pp 37, 40.

4. Ibid, pp 36-37.

5. Ibid, p 36; Izvestiya, 21-7-30.

6. Ek. Zhizn', 19-5-29.

The findings of the NK RKI survey were first presented in Ekonomicheskaya Zhizn' on 19 th May 1929 by M.Kaganovich , and the NK RKI inspectors, L.Lipovetskii and G.Rafalovskii. This was the first association of Mikhail Moiseevich Kaganovich with the machine tool industry, and from this time on he was to be one of its most active promoters. Introducing the report, Kaganovich stressed the vital importance of machine tool building for Soviet industrialisation; "Machine tool building is at the present time that leading link , grasping which, we may pull the whole chain, and in deeds not words catch up and surpass the advanced, technically developed, capitalist countries!"¹ The main target of criticism was the fragmentation of machine tool building; its lack of a real coordinating centre and its low level of specialisation. The Section of Machine Tool Building of VMTS performed some of the functions of a trust and was beginning to introduce some elements of concentration and specialisation of production of machine tools, but , it was claimed , Glavmetall gave it insufficient support. In 1927/28 domestic production met only 19 per cent of needs . Ten factories built machine tools, but these factories were subordinated to no less than eight different trusts and organisations. There was no real plan for factory specialisation. All but one of the factories built a range of other engineering products alongside machine tools , while the basic types of machine tools were built at several factories. Thus, eight enterprises built lathes; five building one and the same size (150mm height of centres) with outputs of 28, 44, 60, 70 and 214 units each. This duplication gave rise to small batch sizes and high costs. The average cost of a machine tool was about twice as great as before the War , and considerable higher than for equivalent foreign machines. There was also much variation in costs between factories , costs tending to be higher at the large enterprises where overheads formed a greater proportion of total costs, because of poor organisation of production. Thus , a shaping machine built by the 'Krasnyi Proletarii' factory cost almost fifty per cent more than a similar machine built at the small 'Samotochka' works.

1. EK. Zhizn', 19-5-29. The following account of the NK RKI findings is based on this source, and the more detailed account in Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, M., 1930, pp146-178.

A second major problem revealed by the survey, related to the question of the lack of central control, was the low level of the design and quality of the machine tools built. There was an acute shortage of skilled design personnel, but design work was nevertheless undertaken by each factory with no general leadership or coordination. Designs were generally chosen by the factories themselves. Foreign designs were inadequately studied, and foreign firms were not involved on a consultative basis. There was very little standardisation even between the models of each individual factory. A tendency towards the building of models of excessive universality and complexity was also criticised. Soviet machines were also extremely heavy compared with equivalent foreign models. With regard to quality, it was admitted that the level was higher than pre-War, but nevertheless considerably lower than for the best foreign machine tools. Materials were of erratic quality, there being no standards. Castings were frequently of unsatisfactory quality and hardness. Heat treatment of lead-screws and spindles was lacking at most factories, with the result that parts deformed very easily. Thus, while the best Soviet machines satisfied the accuracy standards established by the German authority, Schlesinger, the deformation of parts led to a rapid loss of precision. At the time of the survey there was no organisation responsible for the comparative testing of Soviet and foreign machines and factories lacked proper testing facilities. But some technical acceptance conditions were applied by VMTS to ensure a reasonable standard of accuracy. The external finish of Soviet machines was generally poor.

A third group of problems revealed by the survey related to the work of the factories. At the three main enterprises, eighty per cent of the equipment of the machining shops was installed before the War; it was both physically worn and obsolescent, permitting cutting speeds of only 20-30 per cent of modern levels. The production cycle was considered to be over twice as long as it should have been; the average length of the cycle for all models built in 1927/28 was 15.4 months. Equipment and production area were very poorly utilised. According to the VSNKh Five-year Plan, 'Krasnyi Proletarii' was to produce 1,100 rubles of output per square metre of area of machining and assembly shops per year; whereas

in 1927/28 the actual output per square metre had been 397 rubles, compared with only 155 rubles at 'Dvigatel' Revolutsi¹ and 116 rubles at the im.Sverdlova factory. Finally, VSNKh was criticised for not organising any foreign technical assistance for the branch despite its acute problems.

After exposing this formidable catalogue of defects, NK RKI proceeded to outline a series of practical measures for raising the level of Soviet machine tool building. The solution, as presented by Kaganovich, was fundamental rationalisation and reconstruction of the existing factories, with the realisation, in the first instance, of a narrow specialisation of each enterprise. This path was likened to that proposed by Professor Schlesinger for the German machine tool industry¹. But German rationalisation was based on American practice. Thus Kaganovich stated that, "In our development of machine tool building we must emulate the American industry, both in relation to the structure of types built and its rate of development". This specialisation was to be achieved in stages. Firstly, within one year, the factories had to be freed from all non-machine tool production; secondly, during the five years of the Plan factories should specialise in the production of particular types of machine tools, with the aim of one type per factory, except for lathes which were to be built at two factories. Such specialisation was not foreseen in the VSNKh five-year Plan for the branch. According to NK RKI, the VSNKh plan envisaged that 3,300 lathes would be built in the final year by eight different factories. In order to free space for basic production, the making of all nuts, bolts, and other small standard items was to be transferred to a specialised engineering factory; this was to be done by August 1930. Specialisation of factories, the full utilisation of space and equipment, and the undertaking of reconstruction work would give a substantial increase in the output obtainable from existing factories and give the possibility of fulfilling the First Five-year Plan in a manner very different from that envisaged by VSNKh.

There was no properly elaborated Five-year Plan for machine tool building, claimed the NK RKI, and no clear view of machine tool needs. Taking the actual

1. It is not known whether Schlesinger himself participated in any way in the NK RKI survey. He is known to have surveyed the AMO vehicle factory in 1928: T.P.G.30-8-28.

consumption during the two years 1926 to 1928 , 65.1 m.r., as a basis, and assuming an increase of needs of 20-21 per cent a year over five years, NK RKI estimated that total needs would be 300 m.r. , with a demand of 86 m.r. in the final year, 1932/33. The recent new variant of the VSNKh Plan approximated to this, with a demand in the final year of 84 m.r.. But, whereas VSNKh foresaw an output satisfying 62 per cent of needs in 1932/33, or 53 m.r., NK RKI believed that 70 per cent fulfilment could be achieved, i.e. 60 m.r.. Furthermore, whereas VSNKh envisaged that the three main factories would give a combined output in the final year of 22.5 m.r. and foresaw the construction of five new factories, NK RKI was convinced that an output of 47 m.r. could be obtained from the three main factories and additional 10 m.r. from other existing enterprises. The building of new factories was necessary, but not on the scale, nor with the urgency, claimed by VSNKh. Thus, NK RKI advocated an intensive path of development, as opposed to the extensive path adopted by VSNKh.

The crux of the argument presented by Kaganovich and the NK RKI was that machine tool building had to be considered as a separate industry , and not as an activity scattered between a diverse range of organisations. Unified leadership was essential in order to pursue a coherent technical and rationalisation policies. The creation of a specialised machine tool building trust was thus an essential precondition of future progress. While welcoming VSNKh's proposal for such a trust , Kaganovich was critical of the fact that it was to embrace only three enterprises. In the view of NK RKI it had to include six factories - the three main ones, plus 'Samotochka', Im. Lenina and Im. TsK Mashinostroeniya. The trust would exercise general leadership of work connected with planning and projecting new factories. Machine tool sales would be handled through a syndicate.

The board of NK RKI discussed the findings of the survey on 24 th May and during the following two months the report was considered jointly with interested parties, including the enterprises. The proposals outlined above were incorporated in a decree of NK RKI of 31st July 1930, which was accepted by VSNKh as a basis for the rationalisation of machine tool building.¹

¹. Sotsialisticheskaya ratsionalizatsiya..., op cit, p174.

The Creation of 'Stankotrest'.

One immediate consequence of the publication of the NK RKI survey findings appears to have been that Glavmashinstroi turned to STO for a speedy resolution of the question of creating the specialised trust.¹ A report on the problem had been prepared for STO at the beginning of May. This had indicated the necessity of the trust for strengthening technical leadership and deepening the specialisation of factories, but also for facilitating the creation of a strong central design bureau.² Government approval was granted on 29 th May and the statute of the new trust, 'Stankotrest' -the State Trust of Medium Machine Tool Building, was approved by VSNKh on 21 st June. It was to embrace three factories only, despite the demands of NK RKI, possibly because Glavashinstroi did not want to delay its creation by having to overcome the resistance of other trusts. The new trust had an initial capital of 18.9 million rubles and was to operate as an independent economic unit on the basis of 'commercial accounting'.³ 'Stankotrest' was to begin operation on 1st October 1929. At the end of September a further new organisation was created; this was 'Stankostroi', which was to supervise the work of projecting and building new machine tool factories. This organisation was not subordinated to 'Stankotrest', however, but to 'Orgametall', presumably because of the latter's role in projecting the new enterprises.⁴

The first Chairman of 'Stankotrest' was Evgenii Markovich Al'perovich, the founder and former chairman of 'Orgametall'. It is claimed by one modern source that Al'perovich, together with his colleagues in 'Orgametall', was largely responsible for the creation of the new trust.⁵ Al'perovich was born on 16th June 1888 in Gomel'skaya oblast', Byelorussia.⁶ Like many machine tool engineers of the period, he was educated at the Moscow Technical University under an early Russian specialist of metal cutting technology, A.P.Gavrilenko. Al'perovich joined the RSDRP(b) in 1914 and in the following year was exiled for revolutionary activity. After the February Revolution he became a member of the Moscow oblast' bureau of the Party Central Committee and was responsible for Party work with engineers. A member of the Moscow Military-Revolutionary Committee

1. Ek.Zhizn', 25-5-29.

2. Torg.Prom.Gaz., 11-5-29.

in October 1917, he subsequently became Chairman of Moscow oblast' Sovnarkom . As noted above, from 1918 to 1920 he headed the Department of Metal , later Glavmetall, of VSNKh. While head of 'Orgametall' during the years 1924 to 1929, Al'perovich was also a member of the Moscow RKI and the author of a book on survey methods.⁷ It is therefore possible that he was involved in the NK RKI survey of machine tool building, although no direct evidence for this has been traced. In the late 'twenties 'Orgametall' took an increasing interest in machine tool building matters, drawing heavily on the experience of the German industry, which Al'perovich and his colleagues propagated in a number of books.⁸ In the autumn of 1927, Al'perovich/^{visited} the United States and studied a number of machine tool factories.⁹ During his period as head of 'Orgametall' , Al'perovich gathered around him a team of engineers, many of whom entered 'Stankotrest'; prominent members of this group included G.M.Golovin, G.M.Gorokhov, A.A.Zernov and E.E.Levin , the latter becoming the first head of the machine tool industry research institute, ENIMS. Thus 'Stankotrest' began its activity having an experienced and knowledgeable leadership with particularly strong links with the German engineering and machine tool building industries. Al'perovich was to remain chairman of the board of 'Orgametall' on a part-time basis throughout 1930 , but at the end of November the Presidium of the TsKK and NK RKI sharply criticised the work of the organisation and inadequacies of its leadership , and recommended that Al'perovich be replaced by someone who had more time to devote to the rationalisation work for which 'Orgametall' was intended.¹⁰ Shortly before this the Party organisation of 'Orgametall' had been removed for alleged Rightist activities,¹¹ a fact which must have reflected badly on Al'perovich.

3. Sobranie zakonov i rasporiazhenii , 1929, Pt2, No30, pp696-670.

4. Industrializatsiya i stankostroenie - byulleten' ('Stankotrest'), 1930, No.2-3, p69.

5. Stanki i instrument, 1968, No7, p44.

6. Bol'shaya sovetskaya entsiklopediya, M., 1926, Vol.2, p310. Further biographical details are from this source and Stanki i instrument, 1968, No7, p44 (article on E.M Al'perovich, 1888-1938).

7. Al'perovich, E.M., Osnovnye polozeniya po metodike obsledovaniy, M., 1927.

8. Notably: Novosti stankostroeniya v Germanii, M., 1927; and, Al'perovich, E.M.; Levin, E.E. Obraztsovyi zavod, M., 1928. 'Orgametall's foreign contacts are considered in Ch. 9 .

9. Torg. Prom. Gaz., 31-12-27; and, 17-3-28.

10. Za Ind., 30-11-30.

11. Za Ind., 31-10-30.

Soviet writers are almost unanimous in their assessment of Soviet machine tool building in the period prior to 1930 : its development began relatively late, the lack of a single administrative centre held back the branch, the level of specialisation was too low , production methods were primitive, designs were backward , and official attention to machine tool building was inadequate.¹ There is much justice in these criticisms, but Soviet writers tend to play down the real obstacles to the growth of the branch during the period, in particular the uncertainty of policy with regard to industrialisation and the late recognition of the vital role of the machine tool sector . After the trial of the so-called 'Industrial Party' in the autumn of 1930 , Soviet writers claimed that the slow development of the branch was a consequence of 'wrecking' activity on the part of officials responsible for the engineering industry.² As the above account has attempted to show, there were quite sufficient real reasons for the backwardness of machine tool building without invoking the deliberate sabotage of a few malevolent administrators. The leadership of VSNKh does appear to have been slow to recognise the importance of the branch and undecisive in taking practical measures. The Chairman of VSNKh, V.V. Kuibyshev, very rarely made any mention of machine tool building in his public speeches and, despite Mezhlauk's occasional advocacy of it, Glavmetall seems to have devoted very little attention to the branch. With the formation of Glavmashinstroi and a new leader of the engineering industry , A.F. Tolokontsev, who may have had a greater appreciation of the strategic role of the machine tool industry through his work in the defence industry, the situation began to change. But the real pressure for change came from outside the VSNKh leadership, from NK RKI and 'Orgametall'. Within VSNKh and the trusts there does appear to have been, not 'wrecking', but scepticism and an unwillingness to break with the methods and priorities of the past. By October 1929 the forces for change had to a great extent triumphed over those promoting continuity ; the victory was far from complete, but the creation of 'Stankotrest' can be regarded as the effective birth of the Soviet machine tool industry.

1. see, eg., Aizenshtadt & Chikhachev, pp164-167; Lebyachenko, p5; Pivovarov, I., "Sovetskoe Stankostroenie", *Problemy ekonomiki*, 1935, No4, p190.

2. see, e.g., Lebyachenko, p6; *Za Ind.*, 7-2-31; and 27-1-32.; Borisov & Vasil'ev, *op cit*, (1962), p107.

Chapter 3FROM 'STANKOTREST' TO THE PEOPLE'S COMMISSARIAT OF MACHINE TOOL BUILDINGA General Review of 1929 to 1941

This chapter is devoted to a general review of the years 1929 to 1941 as an introduction to more detailed consideration of particular features of the industry in subsequent chapters. Facts relating to the administrative arrangements of the industry, its factories, construction plans and their fulfilment, output plans and their fulfilment, the growth of the product range, the different variants of the five-year plans and the development of the machine tool stock are presented in appendices and so will not be looked at in detail here.

The creation of 'Stankotrest' in October 1929 opened a new stage in the development of machine tool building in the USSR. For the first time a single administrative centre existed with control over enterprises, although at first their number was small. But the birth of the machine tool industry as an independent branch took place at an extremely difficult time when there was considerable uncertainty about the rate and pattern of development of the engineering industry as a whole. The Five-year Plan underwent revisions almost immediately from the time of its official adoption; targets for the building of tractors and agricultural machinery were raised in connection with the collectivisation campaign, but of greater significance was the international situation and measures taken in the summer of 1929 to step up the rate of development of branches connected with defence production.¹ In the autumn a number of major new construction projects were added to the original plan, including a group of aircraft industry factories.² These events had major implications for the machine tool industry if import dependence were not to increase above the level planned, and during the autumn of 1929 there were calls for a revision of plans for the branch. Gurevich, in particular, raised the alarm at the growing import dependence for machine tools and demanded vigorous action to expand the industry and modernise and widen its product range.³

1. Leninskii plan sotsialisticheskoi industrializatsii i ego osushchestvlenie, M., 1969, p.113.

2. Vedushchaya rol' rabocheho klass v rekonstruktsii promyshlennosti SSSR, M., 1973, p.47.

In the autumn of 1929 the final Plan year output target was in fact revised and intentions with regard to the building of new factories changed quite radically. Now ten new factories were to be built over the five years, instead of five foreseen in the previous variant of May. Three new enterprises were to be built during 1929/30 - the original two foreseen in the Plan, plus a new factory of milling machines in Nizhni-Novgorod (Gor'kii). These were to be quite large enterprises; an announcement at the end of the year claimed that they had no equals in the world, except for Britain. The Khar'kov factory was to produce 1,800 drilling machines a year, the Moscow factory 1,200 turret lathes and semi-automatics and the Gor'kii factory 1,300 milling machines.⁴ The original Plan document had expressed caution with regard to the scale of machine tool factories; now nine months later this had been disregarded.

In 1929 machine tool imports were still somewhat below the high level of 1927/28 but it was evident that as plan targets were pushed up imports would grow rapidly and their role increase. While some regarded this prospect with alarm and insisted on an acceleration of the development of the domestic industry, others accepted the situation as an inevitable short term phenomenon, as a component of an overall growth strategy. One of the clearest statements of this view was by Tolokontsev of Glavmashstroi at the Second Session of the Central Executive Committee (TsIK) in December 1929:

"If time had permitted we would have begun to build machine tool factories, factories of presses, conveyers, etc., but now we cannot allow ourselves this luxury. When we have freed resources in just two years time we will be able to seriously undertake the production of implements of production, i.e. to build factories able to equip metallurgical and machine building factories, the chemical, coal and oil industries, etc. At present we produce only a comparatively small quantity of certain types of machines. If we had wanted to solve the problems of machine building by our own technical forces alone we would have fallen behind, and not caught up Europe and America. With widescale use of foreign technology the problem of organising machine building is for us fully realisable".⁵

3. Torg.-prom.gaz., 27.11.29.

4. Ek.zhizn', 22.12.29.

5. 2 sessiya TsIK Soyuza SSR, stenograficheskie otchet, Byulleten' No.11, M., 1929, p.26.

Thus the foundations of the engineering industry were to be laid on the basis of foreign technology; intensive development of the machine tool industry was to wait until resources were available. This approach, as became clear in the following year, was not acceptable to the machine tool industry itself.

On 6th January 1930 VSNKh issued a decree calling for a review of the Five-year Plan for machine building, and Tolokontsev, referring to this, called for study of American technology and organisation, and also, contrary to his previous statement, stressed the need to give particular attention to machine tool building.¹ Shortly before this G.Fedorov had appealed for urgent action to develop the industry in view of the 'famine' of machine tools he saw developing; this famine, he added, was promoting the undesirable phenomena criticised in the NKRKI report of the previous year - low quality products, a low level of specialisation of machine tool building factories and also a tendency for prices to rise.² VSNKh did in fact take action to accelerate the development of the branch. A decree, 'On the state of machine tool building and measures for its further development', of 11th January outlined a programme of action, referring to machine tool building as, "one of the most important factors in the industrialisation of the Union and liberation from foreign dependence". The building of the three new factories was to be accelerated in order to secure their commissioning by the end of 1930/31, a further five new factories were to be projected in 1929/30, a commission on machine tool building was to be sent to the USA and Germany in order to obtain technology from machine tool firms supplying equipment to the USSR, and a group was to be sent abroad to study foreign production methods. Furthermore, the possibility of foreign technical assistance was to be investigated, foreign specialists to be engaged and three more factories transferred to 'Stankotrest (im.Lenina, 'Samotochka' and im.TsK Mashinostroeniya).³ This decree indicated a much more positive commitment to developing the industry than at any time in the past and suggests that the rate of growth of machine tool needs and imports was giving rise to serious concern.

1. *ZaInd.*, 7.1.30.; 8.1.30.

2. *Ibid.*, 3.1.30.

3. *SI*, 1934, No.10, p.5.

This VSNKh decree was followed by two more significant measures. First the output plans of the industry were revised upwards. The new final year target was to be 150 million rubles in import prices (in 1926/27 prices not known), and the extent of satisfaction of needs from domestic production was to rise from 24 per cent in 1929/30 to 40.5 per cent in 1931/32, and presumably a much higher level in the final year given planned needs of 144 million rubles.¹ Second, the project capacities of the three new factories, then being projected at the Berlin office of Orgametall, were substantially increased. The Gor'kii milling machine works was now to produce 3,400 units a year and the Moscow factory 2,400 units.² The projects were approved in May and construction work on all three enterprises began in the summer of 1930. The new factories were to be integrated machining-assembly units, without foundry capacity: castings were to be supplied by specialised centralised foundries.

Despite the evidence of a more definite commitment to development machine tool building on the part of Glavmashstroï and VSNKh, there was still much dissatisfaction with the situation. One of the most vigorous pleas for more action was an editorial of Izvestiya of 10th May, clearly bearing the hallmarks of NK RKI influence. Successes and grandiose plans were, it claimed, diverting the attention of practical workers from the need for a properly thought out plan for the sequential development of different branches of industry and of branches within the engineering industry. A most rapid development of machine tool building, "in all countries the leading branch of machine building", was, it stressed, an elementary condition of further successful development of all industry and liberation from import dependence. The editorial went on to note that the lack of a previous tradition of machine tool building created excellent preconditions for organising the industry on a quite different basis than in other countries, giving the possibility of undertaking the mass production of a narrow product range. Finally, it noted the necessity of preparing the production of American-type, specialised machines required by the auto-tractor industry.³

1. See Appendix 2.

2. Izvestiya, 19.5.30.

3. ibid., 10.5.30.

On several occasions in the weeks preceding the Sixteenth Party Congress Al'perovich expressed concern at the state of the industry, attempting to arouse public opinion in favour of further action. The slow progress of construction work on the new factories was a particular source of concern at this time.¹ At the Congress Kaganovich launched a vigorous attack on the VSNKh leadership for its alleged neglect of machine tool building, employing the materials of the NK RKI survey of the previous year as evidence for his case. He criticised what he regarded as the quite inadequate level of rationalisation activity in the branch, the poor utilisation of capacity, backward models of low quality, and the cautiousness of plans for the industry; plans which had, he claimed, undergone four revisions during the year. There was a lack of clarity on the part of economic organisations, he said, on the question of machine tool needs and this led to a lack of decisive action in developing the industry. The blame for these shortcomings was clearly placed with VSNKh and the former leadership of Glavmashstroï². In reply Kuibyshev acknowledged that more had to be done to develop the industry in order to relieve the machine tool 'famine'.³ The congress called for the forced development of the engineering industry, in particular heavy machine building and the production of machine tools and tooling, for a review of its plans, and for further rationalisation directed towards the specialisation of factories by product, the narrowing of product ranges and the organisation of mass production.⁴ Shortly after the Congress Kaganovich set out his views on the development of machine tool building in the press, citing examples of American practice which he considered worthy of emulation. He called for greater specialisation of machine tool building factories, a reduction of the product range, the organisation of flow production, and the provision of training for skilled workers required by the branch. Any expenses incurred in acquiring foreign technical assistance for developing the industry would, he believed, be quickly recouped. Above all, Kaganovich stressed that machine tool building was a qualitative problem: the production of a large quantity of backward machines would, he stressed, threaten the growth of labour productivity throughout industry.

1. See, e.g. *ZaInd.*, 25.6.30.

2. *XVI s"ezd VKP(b), Sten. otchet.*, M.-L., 1930, pp. 519-522. A purge of the Glavmashstroï leadership was announced in May 1930 - *Izvestiya*, 19.5.30.

Despite the endorsement of the policy of strengthening the machine tool industry by the Sixteenth Party Congress, Al'perovich continued to express concern at the lack of attention to the branch during August and early September. It is clear that the forecast of machine tool demand by the end of the plan period had been radically revised, probably in July. Kaganovich referred to needs in 1932/33 of 250 million rubles (as opposed to 144 million rubles seen earlier in the year) while Al'perovich noted that 42,000 units would be required in that year.⁶ Output plans may also have been changed: Kaganovich indicated a final year target of 150 million rubles. Al'perovich was particularly worried about the industry's investment plans. In 1929/30 14.5 million rubles had been required for the new factories alone, but only 7.5 had been allocated; while for 1930/31 he estimated that 105 million rubles would be needed in order to fulfil the plan, but VSNKh had made clear its intention to only allocate 42 million rubles.⁷ The branch was now committed to further construction projects: a factory of gear-cutting machines was to be built, and also a central, specialised foundry with a capacity of 30,000 tonnes a year to be located in Moscow.⁸ Al'perovich stressed the necessity of putting the construction of machine tool factories into the first priority category for supply purposes. The main task of the period ahead was seen as the introduction of new modern designs, replacing the old, pre-revolution models then in production at all factories. To this end, Al'perovich called for the creation of a "factory of new designs" as a base for building prototypes of the new machines.⁹

On 9th September the Presidium of VSNKh discussed the machine tool industry and the problems of its development. In an article published on the day of this meeting in Izvestiya (a consistent supporter of the industry in 1930) Al'perovich attacked the philosophy of those who, like Tolokontsev in the previous December, believed that machine tool building could wait. Imports were growing rapidly, he wrote, but the problem was not just that tens of millions of rubles foreign

3. Pravda, 12.7.30.

4. Direktivy KPSS i sovetskogo pravitel'stva po khozyaistvennym voprosam, M., 1957, Vol. 2, pp. 194-198.

5. ZaInd., 24.7.30.

6. Ibid.; Izvestiya, 9.8.30.

7. Izvestiya, 5.8.30.

8. Ibid.; Izvestiya, 9.8.30.

exchange was being spent:

"There are khozyaistvenniki who maintain that we still have plenty of time for machine tools, that we can calmly import them from abroad for another two years. Posing the question in this way would have some sense if one were speaking about a temporary increase in the demand for machine tools given the existence of our own technical base in the decisive sectors of machine tool building. But the fundamental question consists in the fact that we build individual, low quality, very simple machine tools, but do not as yet have our own proper machine tool building industry as the principal base for reconstruction of industry as a whole. It is precisely this which is the crux of our foreign dependence in the realm of machine building. In most advanced countries modern machine tool building is characterised by the fact that machine tool and tooling factories do not just supply individual machines to customers, but give them tooled-up technological processes for this or that component. This is why we so often have to go abroad for the elaboration of projects of new production. This is why the creation of our own machine tool building base is the central point of the problem of our dependence on capitalist countries. This is why this question is far from being exhausted by the question of the import of an extra few thousand machine tools"¹

Al'perovich went on to observe that the intended cutback of investment could put back the solution of the industry's problems by yet another year, and raised the possibility that the new factories would have to be put into conservation until resources were available. Events were soon to show that this was no idle threat: work on the new Khar'kov factory stopped and was not resumed for two years.

At the VSNKh Presidium Al'perovich stressed that the main task of the coming year was the transition to new modern designs, and stated that foreign technical assistance was necessary if real progress was to be made. Summing up the discussion, Unshlikht declared that: "The situation with regard to machine tool building is manifestly unhappy, and with tooling - catastrophic".² Following this meeting a decree was issued by the VSNKh Presidium. The main task of 1930/31 was to be the fundamental renewal of designs built, with a transition to new models in the following year. A special research and design base was to be created within Soyuz-

9.1bid. original emphasis.

1. ZaInd., 9.9.30.

2. 1bid., 12.9.30.

stankoinstrument¹, including a central design office and a factory of new designs. The industry was to seek foreign technical assistance and, finally, the industry was to adopt a policy of strictly specialising the machine tool factories.² This decree set the policy for the industry for the next two years and marked a turn in its development.

In 1930 imports of machine tools reached 9,000 units worth 41.5 million rubles compared with 5,000 units to a value of 16.3 million rubles in 1929.³ The trend of development was very steeply rising. Just after the end of the 'Promparty' trial in December 1930 a group of representatives of the industry, including the head of 'Stankostroi' (the industry's construction organisation), Erlikh, forcefully drew attention to this situation in the pages of Pravda. Forecast needs in 1932/33 were 42,000 units worth 270.9 million rubles; output in the final year was to be 152.1 million rubles, covering 56 per cent of demand, compared with an originally planned 17 per cent in 1930/31. But, they wrote, initial claims for 1931 totalled 55,000 units. The rapid development of the industry was therefore essential they urged, both for economic and also strategic reasons. Problems of the industry were explained, they asserted, by the wrecking activities of those responsible for planning the branch in the past, notably Charnovskii, one of the defendants at the trial; and also by the fact that leading economic organs (meaning, evidently, VSNKh) manifestly underestimated the importance of machine tool building. Investment allocations had been reduced to the point that one factory had been put into conservation and another, the Moscow turret lathe works, was now also threatened. A fundamental change of approach was essential, they concluded, if real progress in developing the industry was to be made.⁴

Despite the existence of serious problems and a definite ambivalence on the part of economic and industrial leaders on the question of the priority of the branch, substantial changes took place in 1930, which effectively represented the year of foundation of the modern Soviet machine tool industry. The ambivalence stemmed from a number of factors, notably the ease with which machine tools could

1. This new organisation replaced Stankotrest in June - see Appendix 1.

2. ZaInd., 17.9.30; Izvestiya, 20.9.30.

3. See Table SA.XVI (Statistical appendix).

4. Pravda, 13.12.30.

stankoinstrument¹, including a central design office and a factory of new designs. The industry was to seek foreign technical assistance and, finally, the industry was to adopt a policy of strictly specialising the machine tool factories.² This decree set the policy for the industry for the next two years and marked a turn in its development.

In 1930 imports of machine tools reached 9,000 units worth 41.5 million rubles compared with 5,000 units to a value of 16.3 million rubles in 1929.³ The trend of development was very steeply rising. Just after the end of the 'Promparty' trial in December 1930 a group of representatives of the industry, including the head of 'Stankostroi' (the industry's construction organisation), Erlikh, forcefully drew attention to this situation in the pages of Pravda. Forecast needs in 1932/33 were 42,000 units worth 270.9 million rubles; output in the final year was to be 152.1 million rubles, covering 56 per cent of demand, compared with an originally planned 17 per cent in 1930/31. But, they wrote, initial claims for 1931 totalled 55,000 units. The rapid development of the industry was therefore essential they urged, both for economic and also strategic reasons. Problems of the industry were explained, they asserted, by the wrecking activities of those responsible for planning the branch in the past, notably Charnovskii, one of the defendants at the trial; and also by the fact that leading economic organs (meaning, evidently, VSNKh) manifestly underestimated the importance of machine tool building. Investment allocations had been reduced to the point that one factory had been put into conservation and another, the Moscow turret lathe works, was now also threatened. A fundamental change of approach was essential, they concluded, if real progress in developing the industry was to be made.⁴

Despite the existence of serious problems and a definite ambivalence on the part of economic and industrial leaders on the question of the priority of the branch, substantial changes took place in 1930, which effectively represented the year of foundation of the modern Soviet machine tool industry. The ambivalence stemmed from a number of factors, notably the ease with which machine tools could

1. This new organisation replaced Stankotrest in June - see Appendix 1.

2. ZaInd., 17.9.30; Izvestiya, 20.9.30.

3. See Table SA.XVI (Statistical appendix).

4. Pravda, 13.12.30.

be imported in the crisis conditions of the capitalist world, but also an apparently widely held view that machine tool building was such a difficult matter that it would take years to organise properly. Al'perovich and others tirelessly strived to arouse public opinion to the importance of machine tool building, but with limited success. As a Pravda editorial was to point out a year later, all the country knew about the new turbines and blooming mills, but machine tools were a different matter: 'proletarian public opinion' it concluded, had to be turned to the problem of creating machine tools.¹

Ambitious targets were set for 1931. Output was to total 22,000 units compared with about 8,000 built in 1929/30, while the specialised component of the industry was to build 10,926 units, over twice the achievement of the previous year.² The year opened with an All-Union conference on the problem of renewing the designs built, the main task of the year. Particular stress was placed on strengthening the design forces of the industry, both at the level of the factories, and also by creating a Central Design Office.³ The latter was in fact created in November 1931. In March the VSNKh Presidium approved the organisation of a research institute for the industry; this machine tool and tooling institute (NIISTI) was to start work from June 1931. While work on new designs got underway, including work on a new standard lathe of the latest German design at the 'Krasnyi Proletarii' factory (the 'DIP'), the factories of the branch reduced their product ranges and sharply raised the level of seriality of their production, putting into practice the demand of the VSNKh decree of September 1930. The adoption of this policy of strict specialisation, and its results, is considered in detail in Chapter 4.

During 1931 a number of specialists connected with the industry, or otherwise, put forward radical proposals breaking with the practices of machine tool ^{building} in capitalist countries. These proposals related to the organisation of production, its specialisation, scale and technology, and also to machine tool design. Many of these proposals, although of interest and at times of bold originality, were quite impracticable in the conditions of the Soviet economy of 1931 and 1932. This

1. Pravda, 17.12.31.

2. See Table SA.I.

3. SAI, 1934, No. 10, p. 6.

radical, 'leftist' (as it came to be characterised, because its ideas ran ahead of the possibility of their practical realisation) tendency developed after the 'Promparty' trial and lasted until about the summer of 1932; as will be shown, it had little practical influence on the machine tool industry.

The specialisation policy of 1931, coupled with the general expansion of the industry, led to a rapid upsurge of production. Taking 1931 as equivalent to the 1930/31 economic year of the Five-year Plans, even the most ambitious plan variant was overfulfilled, both in terms of output in rubles, and in terms of total machine tool supply - output plus imports - in units. This latter result was obtained in part because imports rose to an exceptionally high level, 14,000 units worth over 85 million rubles. This level was not to be reached again in the pre-war years. But the import situation was by now deteriorating. In December Al'perovich observed that the crisis was beginning to limit the ability of foreign firms to finance production of machines built to Soviet orders and "substantial difficulties" were being experienced in placing new orders.¹ This, he stressed, necessitated even more intensive development of the Soviet industry. Some idea of the envisaged path of the branch was given in another contribution by Al'perovich in November 1931. In arguing for greater attention to design work, he noted that in addition to the three new factories (two of which entered their starting up period at the end of the year) twelve more new enterprises would be built, and at these and existing factories a total of three hundred types and sizes would be produced.²

The primary problem of 1932 was the assimilation of modern machine tools at the old and new factories. This transition to a new technical level, involving the mastery of complex production technology, took place in difficult conditions in so far as all the factories had experienced a very rapid growth of their labour forces, which had been supplemented predominantly by young, unskilled workers of rural origin. The new models were planned for large-serial production using quite elaborate fixtures and special tooling. The problems of assimilation and

1. SI, 1931, No. 11-12, p. 2.

2. ZaInd., 7.11.31.

their consequences for the path of development of the industry are discussed in detail elsewhere. One result was soon apparent - the rate of growth of output slowed dramatically; in fact output in the specialised industry fell and did not exceed the 1931 level again until 1935. The overall output level was maintained by expanding production at enterprises of the defence industry, which played a major role in developing the production of high quality machines, and other branches of machine building. The number of these so-called 'planned' factories (because the machine tool ob"edinenie had certain planning responsibilities in relation to them) rapidly increased at this time. However, while falling in unit terms, output in value terms rose sharply because the new products had a much higher cost and price than those they replaced.

The year 1932 opened with a major campaign for reducing the level of machinery imports and this was to be a preoccupation throughout the following eighteen months. Machine tool imports did fall somewhat, declining to 12,000 units. But reducing import dependence was not simply a matter of quantity, it was above all a question of widening the product range in order to remove a whole range of types from the import list. This was a major concern of 1932. In the years preceding the Five-year Plan new machine installations had been directed predominantly to branches of small to medium serial production and, as shown elsewhere, the structure of installations did not differ substantially from that prevailing in the pre-Revolution years. But during the First Five-year Plan a substantial shift to large-serial and mass production took place, associated above all with the auto-tractor industry, which was supplied with machines almost entirely of foreign production. At the beginning of 1932 the Soviet machine tool industry built none of the specialised, high-productivity types of machine tools required by mass production branches. Types not built included automatics and semi-autos, almost all types of grinding machine, gear-cutting machines, many types of milling machines, broaching machines and radial drilling machines. Demands that the Soviet industry should begin the production of these types rose steadily in 1931 and the first half of 1932 and culminated in an NKTP Order of 1st June 1932 which called for the development of production of a range of progressive types, including

special machines required by the auto-tractor industry, and also heavy machines required by the rail transport branch and heavy engineering.¹ But the intention to build a wider product range including more specialised types had important implications for the level of specialisation of the machine tool factories and the production methods employed. The next twelve months were a period of struggle for the acceptance of a modified strategy of development putting greater emphasis on the individual and small serial production of high-productivity models. This question is discussed in detail in Chapter Four .

From the beginning of 1932 attention turned to the Second Five-year Plan. The required rate of growth of machine tool output was linked closely to that of machine building as a whole and initial plans for the latter were extremely ambitious. The directives for drawing up the Plan approved by the Seventeenth Party Conference at the beginning of February granted the machine building industry the leading role in the completion of the technical reconstruction of the economy² and called for an increase of output of 3-3½ times compared with 1932. The subsequent instructions for compiling the Plan called for complete freedom from foreign dependence by the end of the period , and called for special attention to be devoted to lagging branches of industry, in the first place machine tool building , which was to radically change its product range.³ Initial plan variants for the machine tool industry , drawn up before the problems of assimilating new models and factories had really been encountered and analysed, were optimistic in the extreme. The process of arriving at a final Second Five-year Plan was in fact the reverse of that for the First: final year targets tended to diminish rather than increase as subjectivism prevalent in economic affairs in 1931 and the first half of 1932 was gradually overcome. The first plan variant for the machine tool industry indicated an eight-fold increase in output in value terms compared with 1932 and a final year target of 80,000 units, compared with a planned 22,000 in 1932.⁴ The share of lathes in total output was to decline to a mere 20 per cent, compared with an actual share in 1932 of almost 40 per cent, while

1. *SII*, 1932, No. 7, p. 2.

2. *KPSS v reolyutsiyakh i resheniyakh s'ezdov, konferentsii i plenumov TsK*, Pt. 3, M., 1954, p. 151.

3. *Osnovnye ukazaniya k sostavleniyu vtorogo pyatiletnogo plana narodnogo khozyaistva SSSR, 1933-1937*, M., April 1932, pp. 21-24.

turret lathes, semi-autos and automatics were to represent 16 per cent of total output (2.8 per cent in 1932) and grinding machines 18 per cent (2.6 per cent).⁵ The machine tool stock was to increase from 200,000 units in 1932 to 600,000 in 1937. A number of speakers at the Seventeenth Conference argued for more vigorous development of the industry, notably Strel'tsov of NK RKI, who stressed the great significance of the branch for the defence of the country.⁶

The June NKTP order provided for a 1937 output of 70-80,000 units worth 750 million rubles, but at the First Conference of Designers, which discussed the implications of this new measure in mid-July, a target of 72,000 units was indicated - the process of cutting it back had begun?⁷ This process was at first gradual; in the autumn of 1932 Zernov, a Stankoob'edinenie worker, indicated that about 69,000 units would be produced in 1937, including 58,000 built by the specialised industry.⁸ The conference of designers was a significant event in the development of the industry because Al'perovich presented a critique of some central aspects of the policy and practice of the previous period, in particular the striving for very large scale production of an extremely narrow product range. A basic lesson of past experience, Al'perovich declared, was that allowance had to be made for technical progress: there were certain laws of machine tool building which could not be ignored.

It was precisely the demands of technical progress and the problems of making a leap to a new technical level which that had been insufficiently taken into account in the First Five-year Plan and the initial variants of the Second. The general problem of technical progress is discussed at length in Chapter 3, where it is argued that at the time of the First Five-year Plan an oversimplified conception of technical development was prevalent and that attitudes were influenced by the crisis of the capitalist economies, at its deepest during the Plan period. There were major achievements in assimilating new technology during 1932, notably the building of the 'DIP' lathe ('Dognat' i peregnat') which came to symbolise the transition to a modern level of machine tool building. This model came in for criticism on the grounds that it was excessively complex and universal, and this led to the holding of a 'trial' of the machine, an event which helped to arouse

public interest in the industry and its problems. Both the new factories, the Gor'kii milling machine works and the Moscow im. Ordzhonikidze turret lathe and semi-automatics factory, built their first batches of new machines in 1932, but experienced considerable problems stemming, above all, from the lack of skills of all kinds. The problems experienced at this time appear to have reinforced the scepticism clearly present in some quarters on the question of the desirability of attempting to rapidly develop the Soviet machine tool industry. These attitudes were vigorously challenged by R. Anders, a leading specialist on foreign machine building and Soviet imports of machinery, towards the end of 1932. He pointed out that machine tools were then accounting for 42 per cent of all imports of industrial machinery - a quite intolerable level. "There are still people", he wrote, "who have learnt nothing from the rich experience of the struggle for Soviet machines of the most complex types. These people strive to convince us that the production of machine tools is an ultra-complex matter, that it demands designers engineers and workers of the very, very highest skills, and that our machine tool building can be developed only at relatively slow rates. It is necessary to put a stop to this chatter in a most decisive way".⁹ Once again, as on many other occasions, this contribution ended with an appeal for the mobilisation of public opinion in support of the industry.

It is not easy to measure the degree of fulfilment of the First Five-year Plan of machine tool building because it is not clear which Plan was actually regarded as definitive, and the change to the calendar year and the fact that it formally ended in 1932 add further complications. Nevertheless it is clear that the branch was quite successful. The Plan as adopted in April 1929 was certainly overfulfilled by quite a large margin, and the revised Plans of 1929 were also overfulfilled in value terms (although there is clearly a problem of prices which cannot be resolved). Performance in relation to the variants of 1930 was also good until the end of 1931, but fell short by a large margin if 1933 is taken as equivalent to the terminal year of the Plan. This shortfall arose largely because

4. See Appendix 2, p. 454. An output of 80,000 units was not in fact attained until 1953.

5. *SI*, 1932, No. 2, p. 2. Actual 1932 see Table SA.VII.

6. *XVII konferentsiya VKP(b), sten. otchet*, p. 195.

7. *SI*, 1932, No. 7, p. 2.

8. *Sotsialisticheskaya rekonstruktsiya i nauka*, 1932, No. 9-10, p. 83.

the transition to new models led to a slowdown in the rate of growth which had not been foreseen by the planners. By the end of the Five-year Plan period import dependence in quantitative terms had fallen below its highest point in 1931. In 1932 domestic production accounted for 60 per cent of supply in unit terms, but 45 per cent in value terms, compared with 24 per cent in the previous year.¹ However, the share of total imports accounted for by machine tools rose, providing a measure of the relative backwardness of the branch. In 1932 metal-cutting machine tools represented 21 per cent of total machinery and equipment imports, and 12 per cent of total imports, compared with 14.3 per cent and 7.7 per cent respectively in 1931, and 6.1 per cent and 1.9 per cent in 1929.² The combination of exceptionally high imports in 1931 and the slowdown in growth of output of the domestic industry meant that total supply in unit terms peaked in 1931; if the simplest types of machines are excluded, this level of supply was not to be attained again until 1936.³ But while substantial progress was undoubtedly made in quantitative terms, formidable tasks remained if the qualitative aspect is taken into account. The output of the industry as a whole in 1932 consisted of general-purpose types of machines, frequently of simple and obsolete designs, and of poor quality. The new models introduced in 1931 and 1932 had been produced in small quantities - 25 'DIP' lathes, 36 turret lathes of 'Warner and Swasey' design, 28 'Cincinnati' milling machines of modern design built by the Gor'kii factory, 60 30mm drilling machines of 'Cincinnati-Bickford' design, etc..⁴ Output of a number of basic older models actually rose to compensate for losses incurred while assimilating new models. The product range was extremely narrow. The main enterprises of the specialised industry built a total of 24 models in 1932, the same number as in 1928/29, and of these 13 were of modern design introduced during the Plan period; these new models accounted for 16 per cent of the total output of "Stankoob"edinenie" in 1932.⁵ Overcoming this bottleneck of the narrow product range was to be the primary task of the Second Five-year Plan.

9.2aInd., 29.10.32.

1. See Appendix 2, p. 452.

2. See Table SA.XVII.

3. See Tables SA.I and SA.XVI.

4. See Table SA.XIII.

5. *Ibid.*

The Second Five-year Plan

The massive transformation of industry and agriculture achieved in the brief period 1929 to 1932, while creating a foundation for independent economic development, the creation of a powerful, modern defence capability, and a fundamental change in social relations, led in the short run to a number of serious problems which required a major reassessment of the prospects for the next five-year period. The collectivisation of agriculture gave rise to acute problems of supply of both food and industrial materials, and also led to a vast migration of population from country to town, which caused serious labour turnover and discipline dislocations. The large-scale industrial construction of the period substantially augmented the capital stock, but the new capacity had only been partially assimilated by the beginning of 1933. The skills associated with modern industrial production were all in short supply, and disproportions in the rate of development of related branches - notably the metallurgical and engineering industries - placed further constraints on production. It has been estimated that the Soviet engineering industry had a potential capacity of 9,000 million rubles output in 1932, but in fact it was able to give only 6,600 million rubles.¹ It was in these circumstances that the Party decided to change the planned rate of output of industry for the coming five-year period: the combined plenum of the Central Committee and the Central Control Commission early in January 1933 reduced the envisaged annual average rate of growth of industry for 1933-1937 to 13-14 per cent, and the assimilation of new technology was posed as a central task of the Plan period.² This compares with the average annual rate of 19.2 per cent claimed for the First Five-year Plan. Shortly after the Plenum Hitler became Chancellor in Germany; the international environment for the USSR, already tense in the Far East, further deteriorated and intensified pressure for the minimisation of economic and technical dependence on the capitalist world.

1. *Istoriya Kommunisticheskaya partii Sovetskogo Soyuza*, Vol. 4, book 2, M., 1971, p. 240.

2. *KPSS v rezolyutsiyakh i resheniyakh ..*, op cit, Vol. 5, M., 1971, pp. 74-75.

The broader economic events described above had immediate repercussions for the machine tool building industry; its Five-year Plan was sharply cutback. The final year target was halved compared with the variant of January 1932, and now stood at 40,000 units, including 26,000 for the specialised industry.¹ In February 1933 a new target was put forward for machine tool building within NKTP - output was to reach 32,150 units, 2.4 times that planned for 1933.² But by May an even lower aim had been set, possibly as a reaction to the deteriorating international situation. The Stankoob"edinenie factories were now to produce only 15,000 units in 1937, compared with an output of 7,311 units in 1932.³ This was to be the lowest plan variant; in the autumn a process of upward revision began again.

Pressure on the machine tool industry was heightened in February 1933, when on the 24th NKTP issued an order forbidding the import of certain types of machinery. Introducing the order, Ordzhonikidze confidently asserted that Soviet machine building had attained such a level that it was now capable of projecting and producing any machine.⁴ Plans for the machine tool industry in 1933 were revised to include new models not originally foreseen.⁵ At the end of April or early May Al'perovich reviewed the new situation, which he characterised as a 'turning point'. He stressed that elimination of dependence on the capitalist countries was now an acute and urgent question, and that an expansion of the product range of the machine tool industry was a basic condition for securing independence and the country's defence. The industry had to adopt a new path, he stressed, involving a rapid expansion of the product range, an increase in the number of types and sizes built by each factory, the transition in many cases from large serial to individual and small serial production, an increase in the number of non-machine tool building factories engaged in machine tool building, a strengthening of the design forces of the branch, and the creation of a sound research and experimental base for the industry. Higher skills would be required for the realisation of

1. *SI*, 1933, No. 1, p. 1. See also Appendix 2, p. 454.

2. *Ibid.*, 1933, No. 2, p. 1.

3. *Ibid.*, No. 4, p. 1.

4. *ZaInd.*, 26.2.33.

5. *Ibid.*, 1.3.33.

this programme , he pointed out, but the previous three years experience had , he believed, provided a good foundation for further raising skill levels.¹

In mid-May one of Al'perovich's demands was realised when NKTP issued an order providing for the creation of an experimental, research institute for the industry on the basis of the already existing NIISTI. The new organisation, ENIMS, started work in the summer of 1933. On 16th June NKTP issued a further order, 'On the development of machine tool building ', giving official endorsement to Al'perovich's call for a change of course, and setting out a programme for the introduction of a further two hundred types and sizes in addition to the forty then in production. The new types were to include grinding and gear-cutting machines and automatics and semi-autos, the production of which was to start by the end of the year.² This order was followed by an All-Union Conference of representatives of the specialised and 'planned' industry devoted to the problem of organising the production of the new models. The 'planned' factories, central control over which was strengthened by the order , were to play a large role in fulfilling the new programme, in particular the military enterprises, which in the following four-five years built the first Soviet examples of a number of progressive types including automatics (1934), centreless grinding machines (1934), surface grinding machines (1935), internal grinding machines (1935), and thread-grinding machines (1937).³ The new models to be built during the Second Five-year Plan were to be based on existing foreign designs, 'translated into Soviet language' by conversion into metric and the adoption of Soviet standards where applicable. The models selected were generally those of the leading foreign firms⁴; there does not appear to have been any direct foreign assistance in assimilating these copies of foreign designs.⁵

Policy discussion, the vigour of which had been a feature of the previous period, temporarily diminished after the appearance of the NKTP order and efforts were concentrated on developing the production of new, modern designs. Total output of the industry, and of the specialised component , increased by only a small amount in 1933, while imports declined to below the 1930 level representing,

however, over a quarter of all machinery and equipment imports. The successful development of a wide range of branches of machine building gave rise to a reduction in the share of total imports accounted for by machinery and equipment, but the relatively slow progress of machine tool building tended to increase its share of machinery imports and also, later in the period, its share of total Soviet imports.⁶

At the end of December 1933 the theses of Molotov and Kuibyshev on the Second Five-year Plan were published; they provided for a machine tool output of 40,000 units in 1937 from NKTP enterprises, i.e. the same total that Al'perovich had put forward in January of the same year.⁷ This total was higher than had been envisaged in the variants of February and, presumably, May, and must have reflected a general upward revision which the planned industrial output had undergone. Now Gosplan was calling for an average annual rate of growth of 18.9 per cent. Before the Plan was approved by the Seventeenth Party Congress NKTP issued an order outlining its version of the Plan for the machine tool industry. This is difficult to compare directly with the Gosplan target of 40,000 because the order did not give an indication of NKTP's contribution, but it can be deduced that intentions were more ambitious. The specialised industry, GUSIP (as it was now known following the amalgamation of the machine tool and tooling industries under a single glavk in August 1933), was to build 30,800 units in 1937, including 7,000 units from new enterprises not yet in action or built, factories of the defence industry were to build 10,750 units, and other 'planned' enterprises 10,650 units, giving an overall output of 52,200 units. Some of the 'planned' factories were under local industry administrations; the NKTP contribution was probably about 45,000 units.⁸ A number of new factories were to be built - two for grinding machines, and others for automatics, gear-cutting machines, heavy machine tools and a shop of precision machine tools.

There was evidently disagreement on the question of the appropriate scale of machine tool production during the 1934-1937 period. The Congress approved the

1. *SI*, 1933, No. 4, pp. 1-2.

2. *Industrializatsiya SSSR, 1933-1937*, M., 1971, pp. 248-251.

3. See Table SA.XIV.

4. See Table SA.XV.

5. See Chapter 9.

40,000 target, but at the same time revised the planned annual average rate of growth of industrial output, lowering it to 16.5 per cent. The originally planned levels of output of iron and steel were also lowered, implying a reduced demand for machine tools.¹ At the Congress Ordzhonikidze spoke vigorously in favour of developing machine tool building and called for the equipping of the automobile factories with Soviet machines. He also noted that in 1937 industry had to produce 40-50,000 machine tools.² M.Kaganovich in his contribution noted that the machine tool industry had made considerable progress, but was still a bottleneck of the economy, and also pointed out that the volume of capital investment required by the branch was insignificant, amounting to a mere 0.47 per cent of all industrial investment. He called for an increase in the investment allocated to the industry during the Second Plan period from a planned 240 million rubles to 350 million rubles³, and claimed that NKTP would itself find the resources to achieve this. Kaganovich concluded by admitting that he personally disagreed with Gosplan on the question of the output planned for the branch. He believed that the 1937 output had to be pushed up to 50-55,000 units, to be achieved by involving more factories in machine tool building. But Kaganovich was not alone in holding this view. Writing in the Gosplan journal, Plan, at about the time of the Congress, I.Pivovarov calculated that total machine tool needs over the five years would be 204,000 units, but the Plan provided for the building of only 129,400 units. Pivovarov therefore called for the maximum utilisation of the existing stock and an increase of output in the final year to 50,000 units.⁴

The Second Five-year Plan set a target of an additional 200 types and sizes to be assimilated, and provided for substantial changes in the structure of output. Milling machines were to represent 10 per cent of output in 1937 (5.9 per cent in 1932), grinding machines 13 per cent (2.6 per cent), gear-cutting machines 2 per cent (nil), turret lathes 10 per cent (2.8 per cent) and automatics and semi-autos 6.6 per cent (nil).⁵ A number of new factories were to be built and start work

1. ZaInd., 30.12.33; 7.2.34.

2. XVII s"ezd VKP(b), sten.otchet, M., 1934, p.171.

3. ibid., p.472. The draft plan in fact allocated 250m.r., raised later to 300. See p.404

4. Plan, 1934, No.1, pp.32-33.

5. Proekt vtorogo pyatiletnego plana razvitiya narodnogo khozyaistva SSSR, 1933-37, M., 1934, p.484.; Actual 1932 from Table SA.VII.

before 1937, including the Khar'kov drilling machine works and the 'Stankokonstruktsiya' experimental and special machine tool factory attached to ENIMS, both of which started work in 1934. Other new factories to be built were a grinding machine works at Khar'kov on the ^{same} site as the drilling machine factory, a second grinding machine factory at Voronezh, a gear-cutting machine factory at Gor'kii, an automatics factory in Kiev, a heavy machine tool works in Sverdlovsk and a factory for precision machine tools.¹ If realised this construction programme would have amounted to a major expansion of the industry's capacity.

During 1934 the machine tool industry struggled to master the building of a range of modern types hitherto not built in the USSR. The plan for new types and sizes was fulfilled with great difficulty and the Glavk's leadership came in for much criticism in the press for its choice of designs and general performance. The problems of this period connected with innovation and the choice of technology are discussed in detail in later chapters. Despite these problems real progress was made in 1934. The product range of the specialised industry widened to 70 types and sizes compared with 26 in 1932, while the 'planned' factories built a further 60 types and sizes.² New types built for the first time included single spindle automatics and semi-autos (the former first produced by the Penza im. Frunze military factory), modern radial drilling machines, a 'Cincinnati' type centreless grinding machine (the Tula arms factory), plano-milling machines and an American type gear-shaping machine.³ The 'Stankokonstruktsiya' factory built the first Soviet high-productivity, unit-construction type machine, although smaller, simpler unit-construction models had been built earlier by the machine tool factory of the Central Institute of Labour.⁴ Total output of the branch exceeded 21,000 units (over 25,000 if simple machines are included), while imports fell to below the level of 1929 and represented only 15 per cent of total supply in unit terms.⁵ Thus, by the end of 1934 the industry was in a generally healthier state. But there was little opportunity to consolidate the achievements; pressure was in fact stepped up further by a new NKTP order of 30th December, which

1. See Chapter 12.

2. See Table SA.XI.

3. See Table SA.XIV.

4. See Appendix 7.

presented a programme for equipping the ZIS and GAZ automobile factories and the Chelyabinsk tractor factory with Soviet machines. These works were to undergo expansion and the machines they required were predominantly of a specialised, high-productivity type.⁶ It is possible that this measure in fact applied as much to the aircraft industry as the auto-tractor branch: at the Seventh Congress of Soviets early in 1935 both Kaganovich and Ordzhonikidze referred to the fact that the machine tool industry had to supply 10,000 machines to the auto-aviation industries in 1935 and 1936.⁷

The year 1935 was one in which the question of technical progress arose as an urgent concern. The industry and the NKTP leadership became aware that technical development of machine tool building was proceeding at a rapid pace despite the economic crisis, which earlier had been regarded as a force severely curtailing technical advance. Precipitate action was initiated to replace a number of models introduced during the previous four years, including the 'DIP' lathe, causing difficulties for a number of factories. This question is examined in Chapter Eight. In March 1935 the Third Conference of Designers was held with the aim of discussing the problems associated with the December NKTP order and a further new order which required the machine tool industry to supply machines to the rail transport industry. This conference marked an important step in the direction of establishing a modern machine tool industry capable of building a wide range of complex, high-productivity equipment required by the leading branches of the engineering industry. It also marked a new stage in the industry's commitment to developing unit-construction machine tool building as a means of introducing elements of standardisation and flexibility into the building of narrowly specialised production equipment. This work was undertaken at the 'Stankokonstruktsiya' under the leadership of the talented young designer, Dikushin. These new demands focused attention on the role of the designer as a central figure in the struggle for technical progress and it was probably the experience of the branch which played an important part in NKTP's decision in July to issue an order designed to secure a higher status for the designer in production.⁸

5. See Table SA.XVIII.

6. Bol'shevik, 1935, No. 6, pp. 13-14.

In the summer of 1935 the question of quality came to the forefront for the first time. The inferior quality of Soviet machine tools had been a feature of the previous period, but it was only when the industry began to supply the leading auto-tractor and aviation branches on a regular basis that it became a serious issue. In 1933 Al'perovich had complained that machine users did not inform the makers of faults; a system of inspectors was organised so that machines could be examined in action at user factories.¹ The reklamatsiya system was developed under which the factory building a faulty machine was obliged to rectify faults stemming from bad workmanship. The most notorious offender in 1934 was the im.Ordzhonikidze factory - over 45 per cent of its output was subject to recall for rectification!² Vigorous action was taken in the following year, however, reducing the proportion to 10 per cent, and only 1.2 per cent in 1936.³ The question of quality was raised sharply in April 1935 by an anonymous contribution by 'a leading machine tool builder' in the pages of Za Industrializatsiyu. He noted that machines installed at the mass-flow production auto-tractor factories had to be especially reliable because if one was out of action it upset a whole production line. Furthermore, he considered that the loading of machines in Soviet vehicle factories was on average higher than in other countries, including the USA, because three shift, and even continuous, work was not infrequent. Therefore, he concluded, the quality demands were exceptionally high; machines had to be reliable and had to retain their high level of accuracy for a long period. But, he observed, the quality of Soviet machines was then at "an intolerably low level". One of the worst problems was low quality gears and splined shafts, which very quickly wore out, and this difficulty was met even at the leading enterprises like 'Krasnyi Proletarii'. He concluded with a plea for a fundamental review of quality inspection procedures at machine tool factories: at the time, he claimed, they just had the role of ensuring that the very worst products were not passed on to customers and standards were not raised because plan fulfilment would be

7.7 S"ezd sovetov, sten.otchet, M., 1935, Byulleten' No.7, p.31.

8. ZaInd., 18.7.35.

1. ZaInd., 2.9.33.

2. SiI, 1937, no.4, p.19. At the first exhibition of Soviet machine tools held early in 1934 one user of a '136' (Warner and Swasey) turret lathe built by the factory wrote in the complaints book: "Clutches do not work; automatic stops do not work; spindle brake does not work; pump does not work; spindle does not stop; driving
cont.next page..

adversely affected.⁴

In May and June frequent reports appeared in the press condemning the poor quality of the Soviet built machine tools then being supplied to the vehicle factories. These complaints related to both specialised factories and the defence industry machine tool builders.⁵ The main causes of the low quality were poor quality materials, an inadequate level of production technology, poor work organisation, inadequate skills and end of month 'storming' which occurred at most factories.⁶ In mid-July 1935 a party-technical conference was organised by the Glavk, with participation by representatives of leading machine using branches, and reports by Ordzhonikidze and M. Aganovich. The problem of quality was the central issue discussed, but there was also criticism of ENIMS and the industry's technical policy, or rather what many apparently considered to be the lack of such a policy. The meeting called for a general improvement of work. A report of the proceedings observed that the 'planned' factories, primarily military enterprises, tended to be much more disciplined than those of GUSIP; they gave machines of better quality and were better at fulfilling plans in terms of quantity. At about this time the industry was given yet another very difficult task - it was to wholly equip a large new bearings plant in Saratov and an extension to the First State Bearings factory in Moscow.⁸

In 1935 the specialised industry built over 10,000 machine tools, exceeding the 1931 level, while together with the 'planned' factories almost 25,000 units were produced. By the end of the year almost fifty enterprises were building machine tools compared with twenty-eight in 1933, and of the total fourteen belonged to the specialised industry, compared with nine in 1933.⁹ The product range rose to 165 types and sizes, and new models built for the first time included surface and internal grinding machines. Imports fell to their lowest level since 1925/26, amounting to only 13.7 million rubles (3,374 units). The year also saw

keys left out; adjustment taper bearing distorted; poor fitting, poor scraping; poor finish; turrets do not line up; locating bushings soft and loose in their seats; carriage feeds with lever neutral; turret and spindle out of line 0.4mm; noisy head". The machinist, Vol. 78, 6.6.34, p. 402.

3. SiI, 1937, No. 4, p. 19.

4. ZaInd., 27.4.35.

5. ZaInd., 15.5.35; 5.7.35.

6. See, e.g. ZaInd., 23.5.35; SiI, 1935, No. 10, pp. 2-3.

7. ZaInd., 14 and 15.7.35.

the start of a campaign for cost and price reduction in the industry , and for profitable operation in order to eliminate the subsidies which the industry was then receiving. The Stakhanovite Movement was quickly taken up in the branch and a rise of labour productivity of 17 per cent was recorded for the year.

In 1936 tension in the economy mounted. In the course of 1935 the deteriorating international situation prompted a revision of plans in order to secure a faster development of the defence industry.¹ Some of the key targets of the 1936 plan were raised above the level originally foreseen in the Five-year Plan, including iron and steel, and the building of tractors, trucks and rail equipment.² In February 1936 NKTP issued an order calling for the conversion of the Khar'kov and Stalingrad tractor factories from wheeled to crawler models³, and this was to pose a major task before the machine tool industry because not only were many general-purpose and specialised machines to be supplied, but ENIMS and 'Stankokonstruktsiya' were to secure the supply of 60 unit-construction machines of 42 different types and sizes , including multi-spindle and multi-station machines. Work on the latter began in May 1936 and they were to be completed by the end of the first quarter of the following year.⁴ The machine tool industry was also striving to fulfil the large order for the vehicle factories, and it is probable that demands for machines for military users were also at a high level at this time. To add to the pressure on industry in general and machine tool building in particular , mounting concern began to be publicly expressed over the danger that Soviet industry was falling behind its capitalist equivalents. These warnings rose in intensity following the Soviet of NKTP in June 1936, at which Ordzhonikidze and others stressed the importance of maintaining a high rate of technical progress. These pressures created an increasingly difficult climate of work for the machine tool industry and criticism of its performance steadily mounted in the course of the year.

Technical progress was a major preoccupation of the machine tool industry in 1936. The Fourth Conference of Designers in April was devoted to the problem

8. *Za Ind.*, 15.7.35.

9. See Table A1.I, p.447.

1. *Istoriya Kommunisticheskaya parti Sovetskogo Soyuz*, M., 1971, Vol.4, book 2, p.350.

2. *The Second Five Year Plan for the development of the national economy of the USSR*, London, n.d., p.111 (in English).

3. *Istoriya Khar'kovskogo traktornogo zavoda im. Ordzhonikidze*, Vol.1, Khar'kov, 1960, p.274.

of securing regular modernisation of designs and the conference resolutions provided for the development of experimental work at the factory level as one means of achieving this aim.⁵ In the autumn attention turned to developing the specialised production of machine tool components and assemblies as a means of raising quality, reducing costs and facilitating the introduction of new models. The development of specialised parts production had frequently been discussed in the past, but the commitment to its practical implementation had been low. Now in 1936 and the first half of 1937 some measures were taken - this question is examined in Chapter Six.

The tasks posed before the machine tool industry in 1935 and 1936 proved too formidable; it was unable to supply on time all the high-productivity machines required for the expansion of the vehicle factories, the reequipping of the tractor works and other major projects. In the autumn of 1935 Al'perovich and other leading figures of the industry travelled to the United States to place orders for machine tools required by high priority projects. Imports in 1936 rose sharply to 8,157 units worth 40.3 million rubles. This was still below the level of 1929, but an unwelcome reversal of a steady downward trend. The share of total imports accounted for by machine tools rose to its highest level yet, 13 per cent, while over one third of all machinery and equipment imports took the form of machine tools.⁶ American machines represented one third of the total imports, while the volume was also influenced by purchases on credit agreed with Germany in the previous year. The output of the specialised industry rose to 13,288 units, and of the 'planned' and specialised enterprises together to 32,408 units, a thirty per cent rise on the previous year. The rise of production of the specialised industry was partly the result of more enterprises entering the Glavk. In 1935 the imeni Sedina works of Krasnodar was transferred, while two new factories began work - a gear-cutting machine factory in Saratov (only the experimental shop was put into action),^{and} a factory of small unit-construction machines in Sverdlovsk. The latter does not appear to have actually built unit-construction machines, rather, ordinary bench type lathes and milling machines, and was located on the site of what should have been a heavy machine tool factory, a project

started and then frozen. In 1936 three more factories entered the Glavk - a new enterprise for the building of automatics in Kiev, the imeni Kirova works of Tbilisi, formerly an oil industry engineering factory, and the 'Stankonormal' works of Moscow, a former repair factory of Remmashtrest, the machinery renovation organisation. The latter enterprise was organised for the production of standard fasteners and other items for the machine tool industry, in addition to the building of grinding machines. Thus by the end of 1936 there were seventeen specialised factories, about ten machine tool building enterprises of the defence industry, and about thirty other factories, usually building machine tools alongside other products.⁷ In December 1936 the defence industry branches left NKTP to form a separate Commissariat, and it is probable that this measure weakened GUSIP's influence on its machine tool building activities. It is notable that from about 1936 the specialised industry strived to organise the production of a number of types, notably grinding machines, formerly the preserve of the defence sector.

On a number of occasions in 1936 there was blunt criticism in the press of the work of the machine tool industry, notably the institute ENIMS. In May one of the Institute's staff, a young specialist on machine tool automation, G. Shaumyan, called for the removal of bureaucratic impediments to creative research and design work, and accused the ENIMS leadership of hindering the development of machine tool technology.⁸ But in September a new note of bitterness was struck. One A. Uspenskii reported on an open Party meeting in the Institute at which very sharp criticism had been expressed of certain aspects of its activity. Uspenskii reported that only 50 of the 530 workers could be considered creative, the rest he termed 'ballast' and 'excess people', whom the Institute would be better off without.⁹ Uspenskii's conclusion that ENIMS lacked 'Bol'shevik spirit' did not auger well for its leadership.⁹ This contribution set the tone for the following unhappy months.

4. SI, 1937, No. 21, p. 8.

5. SI, 1936, No. 6, pp. 1-3.

6. See Tables SA.XVI and SVII.

7. See Table A1.I, p. 447.

8. ZaInd., 17.5.36.

9. ZaInd., 29.9.36.

The plans for the industry in 1937, the final year of the five-year Plan period, were ambitious. The GUSIP factories were to build 20,000 units, factories within NKTP 30,000 (compared with 40,000 foreseen by the Five-year Plan), but the specialised plus 'planned' factories were to build over 41,000 units. This latter figure was effectively equivalent to the Five-year Plan target, because in the course of the Plan period the target for NKTP alone ceased to have much significance, especially in 1937 itself with the splitting off of the defence industry. In assessing the fulfilment of the Five-year Plan the specialised plus 'planned' industry output was always taken. The GUSIP enterprises were to introduce 164 new types and sizes (including unit-construction machines), and a further 64 types and sizes of old models were to be removed from production. In January 1937 the performance of the Glavk was exceptionally bad, attracting much critical attention to its activity: the programme was fulfilled to only 57 per cent, including a mere 10 per cent at the Gor'kii factory and 35 per cent at 'Krasnyi Proletarii'.¹

The situation in the industry, as for the economy and society as a whole, rapidly deteriorated following the February 23rd-March 6th Plenum of the Party Central Committee, and also the death of Ordzhonikidze on 18th February. On the 6th March it was reported that one of the deputy heads of the Glavk had been removed from his post - P.M. Stepanov, who for a number of years had been head of the tooling section of the industry. At the same time the director of the 'Krasnyi Proletarii' factory, Zhabakov, was removed from his post.² This began a process of removing the industry's leaders, which was to continue for several months. The death of Ordzhonikidze was clearly felt deeply by Al'perovich, who seems to have enjoyed very close relations with him. At the First All-Union Conference of Production Engineers of machine tool building Al'perovich described how he had worked 'hand in hand' with Ordzhonikidze over many years and cited examples of his understanding of the specific problems of the machine tool industry. Above all Al'perovich stressed Ordzhonikidze's unwavering concern for raising the technical level of industry, and his appreciation that immediate results were not always obtainable: "He knew", Al'perovich said, "that we are trying to solve

1. ZaInd., 6.2.37.

2. ZaInd., 6.3.37.

complex tasks, that we are working honestly, and that if today we are unable to do something, then tomorrow we will succeed". After a cursory comment on the need to eliminate 'wrecking' activity, Al'perovich sarcastically referred to 'young engineers' who, 'knowing nothing', rejected established methods and experience and tried to enforce their own, new, original ways of doing things. This, Al'perovich concluded, was a sign of cultural backwardness.¹ There could have been no doubt at the time that this was Al'perovich's answer to the critics of the industry, and far from declining the volume of criticism greatly increased

In mid-April the chief engineer of the Glavk was removed, and on the same day an editorial of ZaIndustrializatsiyu, apparently for the first time, referred to 'wrecking' in the machine tool industry.² Early in May Al'perovich in his last major article outlined the path of development of the industry in the Third Five-year Plan. He admitted that there were disproportions in the branch; heavy machine tool building was only just beginning, while the position with regard to small precision machine tools was acknowledged as very bad, no base for their production have yet been organised by the Glavk. These were both serious weaknesses in view of the importance of heavy and precision machines for military production. Al'perovich believed that it would be necessary to have a product range of 1,000 types and sizes in 1942, compared with the 350 which would be in production by the end of 1937. The technical level of products would be raised substantially with development of electrification, hydraulics, higher cutting speeds and automation. An output of 70,000 units would be needed in 1942, and to achieve this he called for the construction of about ten medium sized enterprises, having from 700 to 1000 workers. Furthermore, specialised parts production would have to be extensively developed.³ This contribution provoked a barrage of criticism, usually directed at particular aspects, rather than Al'perovich's general conception of future developments. Krivchanskii, apparently an engineer of the rail transport machine building industry, criticised the Glavk's neglect of heavy machine tools, its investment policy which led to the scattering of resources over many projects,

1. SI, 1937, No. 8, pp. 1-3.

2. ZaInd., 18.4.37.

3. ZaInd., 8.5.37

the fact that the industry's experimental base had been turned into a 'sick child', lack of consultation with users when deciding the range of machines to be built, and finally what he saw as the lack of technical policy for the industry.

Al'perovich, Krivchanskii claimed, had a favourite phrase: "There's no need to chatter about technical policy. It is clear; we are going on the right path".¹

Another critic, Dorogov, criticised investment plans of the branch and called for three to five large factories rather than ten, and also called for a more vigorous approach to specialisation by parts.² There was also detailed criticism of the industry's past neglect of heavy and precision machine tool building.³

At the end of May Al'perovich was personally criticised in an editorial of Za Industrializatsiyu for making what was described as an "unprincipled" speech on restrictions of the supposed rights of a glavk nachal'nik".⁴ He was clearly fighting back against the critics, but it was a losing battle. The Glavk was now coming under fierce attack for its poor performance in fulfilling the top priority order for machine tools needed for the conversion of the tractor factories the conveyors of which stopped at the end of May. In March it had been reported that of 1,225 machines to be supplied, only 268 had actually been received, while by April 'Stankokonstruktsiya' ^{had} built one unit-construction special machine of 29 planned for the first quarter.⁵ At about this time members of the Glavk apparatus were purged.⁶ An editorial of the industrial newspaper at the beginning of June, after cataloguing the failings of the industry, observed that, "In this branch 'worked' enemies of the people - Japanese-German Trotskyist and Right spies and saboteurs. Countless bottlenecks have been created in machine tool building by the hands of the wreckers".⁷ ENIMS came under attack again at the end of June following a meeting of its activists at which Al'perovich and Levin, its director, spoke. By this time 'Stankokonstruktsiya' had built twelve of the machines required by the tractor factories,⁸ and on 3rd July by order of NKTP Levin was removed from his post as head of the Institute and director of 'Stankokonstruktsiya', being held personally responsible for the failure to meet the needs of the tractor industry.⁹ Al'perovich was now made personally responsible for this order, but at the end of July it was reported that the Stalingrad factory was unable to resume work because vital machines had not yet been supplied.¹⁰ The exact date of Al'perovich's removal

has not been found, but it must have been in early August.

In about six months almost all the directors of the specialised machine tool industry's factories were removed, many having been associated with the branch from its foundation in the First Five-year Plan, while many leading officials of the Glavk also lost their posts. As a result, many young specialists and workers rose to leading positions, some, like A.I. Efremov of the im. Ordzhonikidze factory, making extremely rapid progress from ^{the} shop floor to the director's office. Al'perovich, who made such a great contribution to the formation and development of the Soviet machine tool industry, is reported to have died in 1938,¹ at the age of fifty. He was undoubtedly a very competent leader of the branch, with a very clear view of the path of its development and the priorities of each stage. From 1930 he edited the industry's journal, 'Stanki i Instrument', and the frequency of his editorial contributions suggests that this was no formally held post. From 1929 to 1937 he wrote countless articles on the machine tool industry and its problems, attempting always to raise the level of public understanding of its special features and difficulties. The whirlwind of the Ezhovshchina caused a tragic, heavy loss of talent and experience in the still immature machine tool industry at a time when it could least afford it.

The shortcomings of the branch, ascribed in 1937 and 1938 to the 'wrecking' activity of 'Trotskyist-Bukharinite bandits and saboteurs', were many; and there is no doubt that by 1937 a number of serious problems had accumulated because the industry's leadership had been unable to consolidate its gains, under constant pressure of ever more pressing and difficult tasks. These problems included a relative weakness of heavy and precision machine tool building (the latter stemming it appears, from the fact that the Glavk believed that it could be left to the defence industry producers, in so far as this sector presented the largest demand for precision equipment), the slow progress in assimilating basic general-purpose machines for large-serial production at the leading factories, the poor state

1. ZaInd., 10.5.37.

2. ibid., 12.5.1937.

3. ibid., 14.5.1937.

4. ibid., 30.5.1937.

5. ibid., 4.3.1937; 18.4.1937.

6. SI., 1937, No. 12, pp. 1-3.

7. ZaInd., 4.6.1937.

8. ibid., 27.6.37.

9. ibid., 4.7.37.

10. ibid., 30.7.37.

of castings supply, the low level of development of specialised parts production and cooperation, and the poor state of construction work in the industry, which by the end of 1937 had a large number of uncompleted projects.²

The work of the industry in 1937 was poor, with a large shortfall in plan fulfilment. GUSIP built less than 16,000 units against a plan of about 20,000, while the combined specialised and 'planned' industry built 36,120 units, almost 5,000 units below the planned level.³ Imports were less than half the high 1936 total. Instead of the planned 164 new types and sizes, 114 were built, or 78 if unit-construction models are excluded.⁴

Formally, the Second Five-year Plan was quite substantially underfulfilled: factories under NKTP built about 26,000 units in 1937 against a plan of 40,000, while total output over five years was about three quarters of the planned level. However, it is more meaningful to consider the total specialised plus 'planned' output; here performance was better - 90 per cent in the final year and a 3 per cent overfulfilment over five years.⁵ Total output in 1937, including simple machines amounted to 48,473 units. It is also difficult to assess the degree of fulfilment of the 200 new types and sizes target. Formally, it was undoubtably overfulfilled. The specialised industry built 270 new types and sizes over the five years, and the 'planned' factories a further 83, making a total of 353.⁶ But this total includes special unit-construction machines (probably about 50), and many of the new types and sizes cannot have been fully assimilated into production. Complaints about the 'formal assimilation' were frequent: many models appeared in prototype form and entered production much later or, in some cases, not at all. Regardless of this problem, real progress was undoubtably made. The product range of the specialised industry at the end of the Plan period (excluding unit-construction and other special models) was about 150 types and sizes, compared with 26 at the end of the First Five-year Plan, while a further 60 types and sizes were being produced at the 'planned' factories.⁷ A measure of the significant progress of the industry

1. SiI, 1968, No. 7, p. 44. This source provides a brief biography of Al'perovich on the occasion of the eightieth anniversary of his birth.

2. See SiI, 1937, No. 19, pp. 1-2; Planovoe khozyaistvo, 1937, No. 7, pp. 41-46.

3. See Table SA.I

4. See Table SA.XII.

5. See Table, p. 455.

6. See Table SA.XII.

is provided by data on the changing structure of output. In 1937 Soviet industry built 894 automatics (none in 1932); 1,839 grinding machines (254); 397 gear-cutting machines (none); 3,243 milling machines (1,071); 44 broaching machines (none); and 962 special machines (none).¹ Lathes accounted for 31.4 per cent of all machine tools built in 1937 against 39.3 per cent in 1932, vertical drilling machines 25.3 per cent (37.7); turret lathes and automatics 5.5 per cent (2.8); and all types of grinding machines 8.0 per cent (2.6).² However, despite this progress the structure of output was still quite backward compared with the structure of installations during the First Five-year Plan when imports had been at a high level. As is argued later, there was some relative deterioration in the quality of additions to the stock in many branches during the Second Five-year Plan period concern about the danger of falling behind again had real foundation.

Probably the most unsuccessful aspect of Plan fulfilment was that related to the building of new factories. The two new grinding machine works were not even started and capacity was created instead by converting existing enterprises to grinding machine building, while the heavy machine tool building works in Sverdlovsk, which was to have worked on a cooperation basis with the neighbouring Uralmashzavod heavy engineering factory, was started and then conserved. It is clear that investment resources were diverted from civilian to military projects to the detriment not only of machine tool building, but also the iron and steel industry; a fact which was to cause serious problems during the Third Five-year Plan period.³

The Third Five-year Plan

Defence considerations dominated the Third Five-year Plan. The threatening international situation required the Soviet Party and government to intensify the process of economic preparation for the possibility of War, already started in the previous five-year period. Rates of growth were lowered and stress placed on relocation of industry and qualitative changes made necessary by the demands of military production. The output of machine building and metal working was to

1. See Table SA.VII.

2. See Table SA.VIII.

3. See *Istoriya Kommunisticheskaya partii...*, op cit, Vol. 4, book 2, p. 390; Khromov, P.A., *Nekotorye zakonomernosti razvitiya promyshlennosti SSSR*, M., 1963, p. 273.

rise by 2.25 times, compared with a reported fulfilment of the previous Plan of a 2.9 times increase between 1932 and 1937.¹ Information about Plan variants for machine tool building is not as plentiful as for the first two five-year plans, but it does appear that there was less disagreement, the same final year target was first presented in early 1937 and retained in the actual Plan. Total output was to rise to 70,000 units in 1942, compared with 36,120 units in 1937, an increase of 94 per cent, compared with the 105 per cent achieved between 1932 and 1937. The aim for the specialised industry is not known. With the creation of the Commissariat of Heavy Machine Building in February 1939, this was taken as the planning unit; it was to build 43,000 units in 1942, compared with 19,330 in 1937. The machine tool stock of the country was to rise from 380,000 units at the beginning of 1938 to about 600,000 in 1942. The product range was to increase to 800 types and sizes, while the structure of output was to change to provide a higher share of some progressive types, notably automatics and semi-automatics, the share of which was to rise to 6.5 per cent compared with 2.5 in 1937 (the target apparently referred to NKTyazhMash, but this was not specified).² A number of new factories were to be built, primarily to the east of the country.

Information about the work of the industry in 1938 is sparse. Despite the complete renewal of the personnel in leading posts and the general disruption of the time, quantitative fulfilment of the annual plan was quite good. Total output of the 'planned' and specialised industry was equivalent to the 1937 plan target, reaching 40,170 units. Imports reached quite a high level - 6,978 units, and their share in total imports and in imports of machinery and equipment reached its highest point to date - 14 per cent and 40.5 per cent respectively.³ In 1938 a major effort to develop heavy machine tool building appears to have started. Construction work began at the Sverdlovsk heavy machine tool works and at the Kramatorsk heavy machine tool factory, while capacity for heavy machine tool building was created at the Gor'kii milling machine works and other enterprises. In the three years preceding the War the building of heavy machines developed at 'Krasnyi Proletarii', im. Sverdlova, Gor'kii, the Khar'kov factory, the Saratov gear-

1. Tretii pyatiletnii plan razvitiya narodnogo khozyaistva Soyuza SSR, 1938-42 gg., M., 1939, pp. 10 and 19.

2. Ibid., pp. 20, 35-36, and 207.

cutting machine factory, 'Stankokonstruktsiya', the im.Sedina works in Krasnodar, and the Minsk im.Voroshilova factory.⁴ In 1940 212 heavy, large and unique machines were built, of 23 different types and sizes.⁵ Thus one of the bottlenecks of the Second Plan period was to some extent overcome.

At the Eighteenth Party Congress in March 1939 a number of speakers, including Molotov and Malyshev (the Narkom of heavy machine building), placed great emphasis on the importance of raising the share of specialised, high-productivity machines in total output, in particular automatics and semi-autos.⁶ With the outbreak of the Second World War this emphasis became even more marked. On the day after the outbreak of war a major SNK decree outlined the tasks of the industry in the new situation and a number of measures for improving its performance. This decree, while acknowledging the industry's achievements, was highly critical of a number of shortcomings, notably the slow rate of assimilating new, modern types, especially high-productivity models, and stated that this was hindering the introduction of advanced production technology into machine building and the defence industry. Machine tool research and design work was considered inadequate, and designers were accused of failing to adequately study the requirements of advanced technology in the defence sector. The specialised industry Glavk was criticised for being divorced from the work of the 'planned' producers, as also were the other commissariats concerned. The decree outlined a revised programme for the industry, placing greater emphasis than before on the building of automatics, semi-autos, grinding machines and other progressive types, in particular those required by the defence industry. A large construction programme was outlined, with the intention of raising the capacity of the industry to 75,000 units a year by 1942. Some administrative changes were also made. The machine tool Glavk was split into two components, Glavstankoprom, and Glavtyazhstankoprom, the latter including all factories building heavier type machines. Furthermore, the Institute, ENIMS, and 'Stankokonstruktsiya' were transferred directly to NarkomTyazhMash. Finally, a system of bonuses was announced, for stimulating work connected with designing and building new, progressive models, in particular those for military production.⁷

3. See Tables SA.XVI and XVII.

4. *Mekhanizatsiya i avtomatizatsiya proizvodstva*, 1967, No.11, pp.5-6; 1972, No.12, p.13.

5. *SI*, 1970, No.4, p.24.

6. *SI*, 1970, No.4, p.24.

Conditions of work in the machine tool industry, as for industry as a whole, became progressively more difficult in the immediate pre-War period. The output plan for 1939 was not fulfilled; in fact total output fell below the level of 1938. Reasons for this include an increasingly acute shortage of metal, lack of electricity (which for a long period put factories in Khar'kov and Gor'kii out of action), and the fact that enterprises were forced to undertake an increasing number of orders of a directly military nature.⁸ The need to supply machine tools in a short period of time, often of a special and complex nature for military production, led to further imports. In 1939 the number of machines imported was less than in the previous year, but their average weight and value rose very sharply. Furthermore, the role of machine tool imports reached its highest level in Soviet history: no less than 18.4 per cent of all imports took the form of metal cutting machine tools, and over 47 per cent of all machinery and equipment imports, indicating the high priority granted to strengthening the machine tool stock.⁹ Plans for increasing the range of types and sizes built were very poorly fulfilled. In 1939 only 78 new types and sizes were in fact introduced, against a plan target of 155. In the following year performance was slightly better, but still inadequate: 94 new types and sizes were built, against a plan target of 148.¹⁰

In the autumn of 1939 four machine tool building enterprises in Byelorussia were transferred to the specialised industry; these factories had been building machine tools on a fairly specialised basis since the early 'thirties. In building new capacity during the Third Five-year Plan priority was generally granted to projects to the east of the country, generally in the Urals and Siberia. But at the same time the government was anxious to raise output by all means as quickly as possible and this could often best be realised by developing existing enterprises regardless of their location. Time was probably an important consideration in developing heavy machine tool building at Kramatorsk in the Ukraine; as with the Sverdlovsk heavy machine tool works there was an already operational heavy engineering enterprise of large capacity and experience near by, giving the

6. XVIII s"ezd VKP(b), *sten. otchet*, M., 1939, pp. 294-295; 386-387; 653.

7. *Direktivy KPSS i sovetskogo pravitel'stva po khozyaistvennym voprosam*, M., 1957, Vol. 2, pp. 601-606.

8. Kas'yanenko, V. I., *Zavoevanie ekonomicheskoi nezavisimosti SSSR, 1917-1940 gg.*, M., 1972, p. 198. The question of military production and the machine tool industry is considered in detail in Appendix 5.

possibility of quickly organising production cooperation. The primary determinants of location in the 'thirties were the availability of skilled labour and proximity to machine using centres.¹ Heavy machine tool building tended to be located near metallurgical industry centres and bases of heavy engineering - Sverdlovsk, Chelyabinsk and Kramatorsk. The role of the central industrial region as a supplier of machine tools steadily rose throughout the period from 1932, rising from 30 per cent to 37 per cent in 1937 and 46.5 per cent in 1940 in terms of the number^{of} units built. The contribution of the Urals declined in relative terms over the same years, from 14.9 per cent, to 8.6 per cent in 1937 and 4.5 per cent in 1940. In 1940 Western Siberia accounted for only 2.3 per cent of total output. The RSFSR accounted for two-thirds of total output in 1940, the Ukrainian republic one fifth and Byelorussia one tenth.² However, several enterprises were under construction in the Urals and Siberia in the immediate pre-war period and the potential output from these regions was probably considerably larger than the actual output in 1940 suggests. About fifty percent of 1940 output stemmed from regions actually occupied during the War.

Construction plans in 1940 had to be cutback because of the shortage of metal and the growing war danger³. Efforts were made to accelerate the process of raising the technical level of the machine tool stock. A modernisation and modification campaign started, and new procedures were introduced for speeding up the process of introducing new models. The large reserves still present were revealed by a census of the machine tool stock in November 1940. This census appears to have covered the entire stock, whereas previous data always seems to have referred to the civilian sector only.⁴ A total stock of 710,00 units was revealed; but about 46,000 machines were at enterprises and construction sites awaiting installation, and a further 70,000 units were not actually working on the day of the census. Reasons for their idleness included poor organisation, and lack of materials, electricity and workers.⁵

9. See Table SA.XVII.

10. See Table SA.XII.

1. See Zhed', *op.cit.*, p.22.

2. See Table SA.IV.

3. Kas'yanenko, *op.cit.*, p.198.

4. Rozenfel'd and Klimenko, *op.cit.*, p.364. state that "a large part of this equipment was used for the production of military technology", referring to the 1940 stock.

5. Planovoe khozyaistvo, 1941, No.3, p.34.

Attention to the machine tool industry heightened in the autumn of 1940. In September-October an All-Union meeting on the industry was held, in which participated Party leaders, Malyshev (then deputy chairman of SNK USSR) and Efremov, the Narkom of heavy machine building. One of the main aims of the meeting was to devise policies putting an end to machine tool imports.¹ Performance was poor at this time: fulfilment of the programme for NKTyazhmash enterprises in the first nine months of 1940 reached only 73 per cent.² At the beginning of November 1940 a commission was created under the chairmanship of Malyshev to prepare a new decree providing for an upturn in the development of the industry. The result was a decree of the Party Central Committee and Sovnarkom USSR dated 8th December. This decree has not been published and can only be pieced together from a number of secondary sources, but it is evident that it presented a programme for a major transformation of the machine tool industry. It stressed the first priority importance of providing metal working equipment for the aviation, tank and artillery industries, and indicated the necessity of using foreign experience.³ This raises the possibility that foreign technical assistance may have been envisaged - from Germany? The decree provided for the transfer of a further ten enterprises of other administrations to the specialised machine tool industry, including three labour communes of NKVD. An ambitious construction programme was outlined: twenty-five new factories were to be built, plus a further six for allied production.⁵ Measures were also taken to enhance the role of the designer in developing new machines, with the introduction of new bonuses and a provision that machines could be named after designers.⁶ It is not known how much of this decree was actually put into practice before the outbreak of War.

A total of 58,473 machine tools was built in 1940; 42,500 if simple types are excluded. This latter total was 80 per cent of the level it should have been for fulfilment of the Five-year Plan. Imports rose somewhat in unit terms over 1938 but there is reason to doubt the usually published figure given the intense activity for developing military production and, in fact, a recent source does suggest a much higher level of imports in 1940 - 9,274 units.⁷ The programme for raising

1. Kas'yanenko, op cit, p.198.

2. ibid.

3. ibid, p.199.

4. Zhed', op cit, pp.15-16; Aizenshtadt and Chikhachev, op cit, p.220.

the share of automatics and semi-autos met with some success. In 1940 3,136 units of these types were built, representing 3.5 per cent of total output (including simple machines), compared with 894 units and 1.8 per cent in 1937. The share of ordinary lathes in total output fell to its lowest level yet - only 19.7 per cent; the share of grinding machines of all types reached 11 per cent, compared with 8 per cent in 1937. The biggest increase was in the production of special machine tools, presumably for military production purposes; their output rose from 962 units to 6,688 units in 1940, when they represented over 11 per cent of the total.⁸ Thus a quite significant qualitative change took place during the three years, 1938 to 1940. By the end of 1940 the specialised machine tool industry was building 320 types and sizes, over twice the number in 1937, while in the country as a whole about 500 types and sizes were being built.⁹ This was quite a considerable achievement and testified to the growing maturity of the industry's design and engineering forces.

There is little information about the work of the machine tool industry in the final months before the War. A report of work in the first quarter referred to the successful fulfilment of plans by Glavstankoprom, including the fact that it had fully fulfilled the plan for assimilating new models - a rare achievement!¹⁰ On 5th June a People's Commissariat of Machine Tool Building was created, signifying the high priority granted to the branch at that time. Also in June the government gave a directive for an increase of output in the year 1941, and it was decided that the production of machine tools at the enterprises of the armaments' commissariat, NKVooruzhenie, should be restored.¹¹ It is not known when the enterprises of this commissariat ceased building machine tools, but it was probably in 1940, because the September 1939 decree foresaw a major role for them, suggesting that they were in action in that year. The withdrawal of these enterprises may account for some of the shortfall of output in 1940.¹² In the first half of 1941 a total of 28,100 machine tools were built. The volume of imports is not known.

5. Zhed', op cit, p.16.

6. Kas'yanenko, loc.cit.; Omarovskii, op cit, p.86.

7. See Table SA.XVI.

8. See Tables SA.VII and VII.

9. See Table SA.XI.

10. Industrialization USSR 1938-1941 gg. M., 1973, p.204.

By the outbreak of war the Soviet Union possessed a modern machine tool industry able to build almost any type of machine and meet almost all the needs of the economy. During the Third Five-year Plan years 1938-1940 domestic production accounted for about 94 per cent of total supply in unit terms, compared with 86 per cent during the Second Plan and 56 per cent during the First Plan period. But there were definite weaknesses; the product range was barely sufficient, the technological level of many models was below the latest standards of foreign machine tool building, quality and reliability were not up to foreign levels, the capacity of the industry for original design thought was still limited, etc.. Before considering some particular aspects of the development of the industry in more detail, it is interesting to compare the position reached by 1940 with the situation in the two main machine tool building countries, the USA and Germany.

Table 3.1

Machine Tool Output and Stock in the USSR, USA and Germany 1937-1940

	<u>USSR</u>	<u>USA</u>		<u>Germany</u> ¹	
	1940	1937	1940	1938	1940
Output of metal-cutting machine tools (units)	58,473	55,000	110,000	119,800	139,500
Stock of metal-cutting machine tools in the economy ('000 units)	710	n.a.	1,000 ²	958 ²	n.a.
Per cent of stock under ten years old	71		28	34 ³	

1. excluding occupied territory.

2. industry only, not whole economy.

3. under eight years old.

Source:

USSR - Output, Table SA.I ; stock and age - Narodnoe khozyaistvo SSSR v 1962g., M., 1963, p.55.

USA - Output, Wagoner, H.D., The United States Machine Tool Industry, 1900 to 1950, M.I.T., 1966, pp.362-363.; stock and age - Omarovskii, op cit, p.68.

Germany - Output, The Effects of Strategic Bombing on the German War Economy, The United States strategic bombing survey, 1945, p.224 (adjusted to remove metal-forming machines); stock and age - ibid., p.229 (also adjusted).

Thus the industrialisation drive gave the Soviet economy a remarkably young machine tool stock, but its size was still quite substantially smaller than in Germany

11. Kas'yanenko, op cit, p.200.

12. And also some of the recorded decline in output to the east of the country: e.g., output the Udmurt ASSR (probably entirely the Izhevsk factory of NKV) declined from 2,212 units in 1937 to 1,441 in 1940 (Narodnoe khozyaistvo Udmurtskoi ASSR, Izhevsk, 1957, p.22.).

1. See Table SA.XVIII.

and the United States. Output in 1940 exceeded the US output of 1937 (50,000 in 1929 and 34,000 in 1938) in quantity terms, but in quality there was probably a substantial difference. Its potential output was much lower however - the USA was able to increase its production from 51,500 units in 1939 to 110,000 in 1940. The Soviet output was much lower than that of Germany, and by 1940 the latter had the possibility of using quite substantial capacity in occupied countries. Thus Soviet industry was at a distinct disadvantage from the point of view of machine tool supply at the time Germany attacked.

Chapter 4THE STRATEGY OF DEVELOPMENT OF THE SOVIET MACHINE TOOL INDUSTRY

Given the decision to develop a strong machine tool building capacity the leaders of the industry were faced with the problem of what path to follow. It was generally acknowledged that the scattered, universal production of Tsarist Russia, based on primitive technology, had to be superseded, but it was not easy to devise an alternative strategy appropriate to Soviet conditions. Should the branch follow an existing model and adopt the organisation and methods of a machine tool industry of an industrially advanced capitalist country? If so, which country - Germany or the United States? Or, should all capitalist models be rejected and a new strategy devised specifically tailored to the circumstances and possibilities of the socialist, planned economy? This last alternative was attractive, but for its successful adoption a good understanding was required of what features of the machine tool building of other countries were specifically capitalist, and what features were peculiar to the activity of machine tool building itself. The problem of strategy involved a number of central issues relating to the organisation of production, notably the scale of factories, their degree of specialisation by product, the extent of process and parts specialisation, the technology of production, the size of the product range, and the role of standardisation. Solutions to all these problems had to be devised in a very brief period of time; whereas in other countries organisational forms and methods had evolved over decades. Furthermore, they had to be devised at a time when technical and managerial skills were in extremely short supply. This chapter is devoted to an examination of the evolution of the strategy of development of the Soviet machine tool industry in the pre-war years, with particular emphasis on the influence of foreign, capitalist practice and the extent to which an original industrial structure appropriate to Soviet conditions was created.

Before considering the Soviet industry it is necessary to briefly review some of the main features of the organisation and methods of the machine tool industries of three leading industrial countries - Germany, the USA and Britain -

in order to more precisely determine the extent of their influence on Soviet theory and practice.

The German Machine Tool Industry

In considering the German industry distinction must be made between its traditional features and the new approaches which gained strength in the 1920s. The pre-First world war German engineering industry as a whole and the machine tool industry in particular were characterised by a predominance of unspecialised, individual and small serial production with a heavy reliance on skilled labour. Large-serial and mass production were the exception and little use was made of specialised and special purpose equipment. After the War the industry possessed very considerable excess capacity and the drive for profitability in these circumstances led to the vigorous promotion of techniques of rationalisation. The rationalisation movement was energetically pursued in the machine tool industry with active assistance from the German machine tool builders association (Verein Deutscher Werkzeugmaschinenfabriken).

The main directions of rationalisation in the machine tool industry were as follows.¹ First, the association of firms engaged in similar lines of production in order to reduce competition and make the fullest use of available capacity. Some of these associations were directed towards the pooling of sales efforts, but others involved far-reaching production cooperation. The most notable case of the latter was the formation of Verein Deutscher Drehbankfabriken (V.D.F.), an association of four leading lathe building firms (Boehringer, Braun, Heidenreich und Harbeck, and Wohlenberg) in order to build a range of standard centre-lathes.² A feature of the German machine tool industry of the early 'twenties was the considerable diversity of the product range with much duplication and consequent short production runs. Many factories made a number of types of machine having

1. The general features of the German rationalisation movement are described in detail in Brady, R., The rationalisation movement in German industry, Univ. of California, 1933. A comprehensive account of rationalisation in the machine tool industry is provided by Wegeleben, F., Die Rationalisierung im Deutschen Werkzeugmaschinenbau, Berlin, 1924.

2. See below, p. 102.

little or no technical homogeneity. The second main direction of rationalisation was therefore the specialisation of factories by specific types of machines. This factory specialisation by product was frequently linked with the 'tipification' (tipisierung) of the machines built, i.e. the reduction of the range of sizes built of any given type, thereby permitting a higher degree of seriality of production. This latter aim was also pursued by the standardisation (normalisierung) of parts and assemblies of machines of a given type, and sometimes, at a higher level, of parts and assemblies common to machines of different types. With the possibility of raising the level of seriality of production offered by these rationalisation techniques machine tool firms began to introduce new systems of limits and tolerances allowing interchangeable parts production. Finally, the larger batch sizes gave the possibility of introducing elements of continuous flow production for some machining processes but, more frequently, for assembly processes. The introduction of flow organisation involved intra-factory reorganisation with the relocation of machine tools from the traditional group arrangement (groups of similar types of machines) to arrangement according to the flow of work for particular machine tool assemblies. This generally involved the creation of specialised bays for the machining of such main elements as beds, headstocks, tailstocks, etc. A notable feature of all these forms of rationalisation, which owed much to progressive American practice, was that they were predominantly of an organisational nature, requiring little if any additional capital investment.

By 1928 the German machine tool industry was still characterised by a production base consisting of a large number of small factories (865 factories with an average of 75 workers each¹) with considerable duplication of effort, e.g. there were 90-100 producers of lathes alone - 'sufficient for enormous overproduction. But by this time the new tendency was clear to foreign observers. Thus a British visitor to the 1928 Leipzig Fair noted that for German firms, "...the trend is directed towards the production of only one class or kind of machine tool and

1. The iron age, 19.4.1928, p.1097.

2. ibid.

within that class of only one model or size of machine tool".¹ The specialisation of the German machine tool industry was also stressed by a Soviet specialist, Lazarev, writing in 1929;" Clear specialisation is characteristic of the vast majority of German machine tool building factories. If one leaves out of account the small number of relatively large factories employing 1,000 to 2,000 workers (e.g. Loewe, Reinecker, Werner) ... then the majority of machine tool factories with from 100 to 300 workers are narrowly specialised, allowing them to compete on both German and foreign markets".² Moreover, Lazarev noted that specialisation was expressed not only in the limitation of the product range, but also in a narrowing of the range of productive operations undertaken;" For the present day organisation of German machine tool factories the lack of foundries (often forges as well) is becoming all the more typical ... as a result the machine tool factories are being transformed into purely mechanical enterprises (machining and the assembly of products)".³

The most comprehensive case of rationalisation in German practice of the 'twenties and early 'thirties was that of the VDF combine. This firm took rationalisation further, both in relation to product design and organisation, than any other German machine tool builder, and this experience can be regarded as the most advanced European practice of the period. Moreover, it had no parallel in the United States at this time. The VDF standard lathe was designed as a unified range of machines incorporating many standardised components and assemblies common to the machines of different sizes. For the first time in practice the machines were built with a standardised range of feeds and speeds according to the theoretical principles elaborated by Professor Schlesinger. As the editors of the British journal, 'Machinery', observed in 1929, the VDF lathe represented "...the most important attempt at rationalisation which has yet been made in the machine tool industry".⁴ Each of the four member firms of the VDF combine built two or three sizes of the range and this high degree of specialisation permitted the

1. *Machinery*, 13.12.1928, p.351.

2. *Ekonomicheskoe obozrenie*, 1929, No.6, p.47.

3. *Ibid.*

4. *Machinery*, 12.9.1929, p.756; see pp.771-773 for a description of the lathe.

use of quantity production methods hitherto considered inappropriate to machine tool building. Thus the Boehringer works built only two sizes with a programme of 75 units a month (900 a year). Considerable use was made of special jigs and fixtures and flow line organisation of machining shops was adopted wherever possible. Special bays were organised for the assembly of such units as headstocks, tailstocks and saddles. Detailed work cards were prepared for each separate operation and interchangeable parts eliminated the hand fitting hitherto typical of the industry. It was claimed that this system of production gave considerable space savings without the need for additional capital investment, and could give a saving in wage costs of up to thirty per cent.¹

The lathe built by VDF was a universal machine designed for use in toolrooms, repair shops and a wide range of individual and small-medium serial engineering production. Throughout the 1920s the German industry concentrated on the building of such general-purpose machines suited to the conditions of German engineering production, and it was only towards the end of the decade as rationalisation deepened giving rise to an increasing adoption of quantity production methods that the industry began to build more specialised models. This tendency was noted at the 1929 Leipzig Fair.²

The American Machine Tool Industry

The main machine tool building countries of Western Europe were concerned almost exclusively with the production of general-purpose machines finding wide application on both domestic and export markets. Special purpose machines were also built, but these tended to be of the heavier types required for such branches as rail transport machinery and ship building. The very marked product differentiation characteristic of the industry hindered the adoption of quantity production methods. The rationalisation movement therefore focused on the reduction of this diversity in order to secure cost savings derived from a greater seriality of production possible because of the nature of the general-purpose product. The position of the American machine tool industry was rather different. The strength

1. See Schütz, W., 'The mass production of lathes', *Engineering*, 14.8.1931, pp.185-188; and *Machinery*, 29.10.1931, pp.137-138.

2. *Machinery*, 12.12.29, p.380.

of the industry was not in the building of general-purpose equipment (although it should be stressed that good machines of this type were built, mainly for the domestic market) but in supplying specialised production equipment suited to the demands of quantity production branches, above all the mass-production motor industry. The specialised nature of this equipment, frequently built to meet the specific demands of customers, necessarily gave rise to great product differentiation and the predominance of individual and small-serial production, relying heavily on highly skilled labour.

American machine tool factories of the 1920s were generally small in scale. In 1929 the average number of workers per factory was 169, but many of the best known firms building specialised machines had from 300 to 800 workers (e.g. Bullard, Cone, Fellows, Cleveland, and Kearney and Trecker). These factories tended to be specialised for the building of a particular type of machine tool, but often built many models and sizes of this type. There were a few larger factories of 2,000 workers or more (e.g. Browne and Sharpe, Pratt and Whitney, Cincinnati Milling) but they tended to have a lower level of specialisation. Although American firms tended to specialise by type of machine, a Soviet specialist, after visiting American machine tool factories in 1927, observed that while as in Germany there was a striving for specialisation there was a greater differentiation of the product range.¹ But the American industry had a higher level of specialisation of a different kind - in the production of components and assemblies common to machine tools of many types, e.g. pumps, fasteners, electrical and hydraulic units, etc.² This highly developed system of sub-contracting gave scale economies which counteracted the raised costs of low-quantity production of the machines themselves. This sub-contracting also extended to the supply of castings and forgings: in the 1920s most American machine tool firms did not possess their own foundries.³

The nature of the industry's products (specialised production equipment) promoted the development of very close relations between the machine tool firms and their customers, especially in the motor industry. In fact the customers tended to dominate the machine firms, the monopoly power of the large motor industry corporations being an important factor in this subordination. A characterisation

1. Al'perovich, Torgpromgaz, 31.12.1927.

2. This was also noted by Al'perovich, ibid.

of the American machine tool industry in the early 1960s applies equally to the situation of the inter-War years:

"The machine tool industry has traditionally been dominated by its customers. This has expressed itself in a number of ways. The industry has based itself on customer service, tailoring products to customer demands on what has been almost a custom basis, rather than making products to a price and merchandising them. This has tended to make the industry a giant job shop, with low production runs, high costs, low profits and high prices in comparison to the mass production machine tool industries of other countries. The industry has relied for direction in development work on what the customer wants. In recent years this has been particularly true of the industry's relations to the automobile industry".⁴

The favourable market conditions of the 1920s did promote some measures directed towards the rationalisation of machine tool production in the American industry, especially for firms building machines of a general-purpose nature. A pioneer in this respect was the Jones and Lamson company, which in the early 'twenties rationalised its product range (turret lathes) and reorganised shop equipment from the traditional group arrangement to a layout by product securing elements of flow organisation.⁵ A British observer at the end of 1929 noted that American machine tool builders were increasingly adopting the line system of layout with a tendency to departmentalise shops by product rather than process.⁶ Thus the line of rationalisation pursued by the German industry was also being followed in the USA, but in the latter case it does not appear to have been carried as far. By the end of the decade the American industry was beginning to show interest in a new form of rationalisation better suited to the demands of low-quantity production of specialised machine tools. This was the unit-construction principle, elements of which were incorporated in new Cincinnati milling machines introduced in 1929.⁷ The merit of this principle lay in the fact that it introduced elements of quantity production into what had hitherto been almost exclusively individual and small batch production.

3. See Chapter Five.

4. *Patterns and problems of technical innovation in American industry*, Washington, 1963, p. 111. (A.D. Little report to the National Science Foundation).

5. *Transactions, ASME*, Vol. 46, 1925, pp. 696-712. M. Orentlikher presented an edited version of this article in *Stanki i instrument*, 1930, No. 1-2, pp. 22-28.

6. *Machinery*, 12.2.1929, p. 338.

7. *ibid.*, pp. 336-339.

The British Machine Tool Industry

There is no evidence that British machine tool building had any direct influence on Soviet practice except, perhaps, by negative example. The British machine tool industry had a structure somewhat similar to that of the German industry, concentrating on general-purpose machines (frequently of a low technical level because of the existence of large, protected colonial market) but with a lower level of specialisation and less progressive production organisation and methods. The real strength of the British industry was in the building of heavy machine tools of the types required for making rail equipment, ships and other heavy engineering products. The British industry did have the largest machine tool factory in Europe (Alfred Herbert) employing up to three thousand workers, but this factory had a quite broad profile, building lathes, semi-autos, and milling machines. Apart from a few other relatively large factories employing over 600 workers (e.g. Ward, Lang, Churchill) most enterprises employed under five hundred.¹ Many factories lacked a clear profile, building a very wide range of products: a Soviet observer after a detailed study of thirty-four firms (including all the leading producers) concluded that, "Only in exceptional cases does narrow specialisation by type of machine tool take place".² This same well-informed observer also noted that the British machine tool industry differed from those of America and Germany by the worse state of its equipment and the backwardness of its production organisation: "Individual, kustar approaches to machining parts and the assembly of machine tools continue to be the rule in the British machine tool industry".³ Oborin also noted that despite the poor equipment and methods some small firms were able to produce machines of high quality because of the presence of very highly skilled workers. There were some exceptions to the general rule, however, e.g. the Herbert company produced on a large-serial basis with a large number of fixtures, but the Parkinson company of Shipley was alone in 1932 in having all its equipment arranged in specialised bays making specific parts with machines located according to the flow of work.⁴

1. Burn, D. (ed.), The structure of British industry; a symposium, Cambridge, 1958, Vol. 1, p. 374; SI, 1931, No. 11-12, p. 1.; Oborin, V., Vestnik metallopromyshlennosti, 1932, No. 10, pp. 56-58.

2. Oborin, op cit, p. 56.

3. ibid., p. 57.

4. ibid., pp. 58-62.

During the First World War government pressure for greatly increased machine tool output had led to the adoption of rationalisation measures of a kind similar to those typical of the German industry, including reduction of product ranges, specialisation of factories by type. "The trend towards specialisation, standardisation and rationalisation was not of course reversed but after the early 1920s it had lost much of the impetus derived from the War and rationalisation certainly never occurred to the same extent as in Germany".¹ In another respect the British industry was less specialised than those of Germany and America: relatively more factories possessed their own foundries. Of the thirty three factories visited by Oborin in 1932, thirteen had their own foundry capacity, although some of these received castings from other firms as well. Some of the largest factories (e.g. Herbert, Lang, Asquith, Archdale and Butler) had their own foundries, but most were too small to have their own capacity and were supplied by jobbing foundries.²

The Strategy of Development of the Soviet Machine Tool Industry

In considering the broad strategy of development of the machine tool industry three phases can be identified, distinguished by fairly distinct policies and practices. Although it is not easy to precisely delimit these phases chronologically convenient boundaries are provided by major official measures directed towards securing a change in ^{the} hitherto accepted path of development. Thus, Phase One can be seen as the period from the beginning of the restoration of machine tool building, say 1925/26, to the meeting of the VSNKh presidium in September 1930; Phase Two, from September 1930 to June 1933 (the NKTP order No. 557 of June 16th); and Phase Three the period from June 1933 to 1941. The provisional nature of this periodisation will become apparent in the discussion which follows; there were no abrupt changes of course.

Phase One, 1925/26 to September 1930.

a) Policy

The machine tool section of the metal industry syndicate, headed by M. Orentlikhe

1. Aldcroft, D.H., *Business history review*, 1966, No. 3, p. 291.

2. Burn, *op cit*, p. 379; Oborin, *op cit*, pp. 57-62.

put forward a coherent strategy for the development of the industry from the time of its formation in 1926. The aims of policy can readily be identified: first, to restore machine tool building at a number of enterprises (generally having previous experience) and increase output to meet growing needs at a time when imports accounted for a very substantial share of total sales; second, to raise the technical level of the machines built; third, to greatly reduce the cost of domestically produced machine tools. The external influence is easily identified as that of the German rationalisation movement, and this influence was frankly acknowledged by Orentlikher himself. Outlining policy for the branch in 1926 he stated that rationalisation had to be the focus of all activity, and that "the paths of rationalisation of machine tool building have already been laid down by American and German tool builders".¹ Despite the reference to American practice (the rationalisation movement in Germany had its origins in efforts to 'Americanise' German industry, but later developed its own features) the content of the policy put forward was an exact parallel of that then being pursued by the German machine tool industry.²

The main elements of policy at this time were, first, the specialisation of factories on the building of a limited number of types and sizes of machine tools; second, in order to promote this specialisation the number of sizes of machines built was to be rationally reduced ('tipizatsiya'); third, the standardisation of parts and assemblies was to be developed, and fourth, the seriality of production was to be raised, largely as a consequence of the first three measures, allowing the adoption of more progressive production technology and organisation, with consequent cost savings. At this time efforts were centred on the building of relatively simple universal type machine tools; more specialised models were obtained from abroad. This rationalisation policy was expounded on several occasions between 1926 and 1929 by Orentlikher, but from the beginning of 1929 policy discussion intensified and broadened in terms of participants. Before

1. Sistema i organizatsiya, 1926, No. 4, p. 11.

2. Note, the Soviet vocabulary of rationalisation was drawn directly from the German: ratsionalizatsiya/ratsionalisierung; spetsializatsiya/spezialisierung; tipizatsiya/tipisierung; normalizatsiya/normalisierung. The Soviet term 'poŭchnoe proizvodstvo' was introduced in 1926 as a direct equivalent of the German 'Flieissarbeit' in a deliberate (and eventually successful) attempt to supplant the vague term 'fordizma' then in general use to describe flow production (see ibid., 1926, No. 1-2, p. 6).

considering the policy discussion which preceded the transition to the next phase, it is useful to briefly recall some of the main features of the practice of the industry prior to 1929.

b) Practice

The development of machine tool building prior to the formation of Stankotrest has already been considered in Chapter Two. As was revealed by the NK RKI survey in the spring of 1929, practice diverged substantially from policy, above all because there was no single organisational centre for the branch. Factories were subordinated to a number of different trusts; they produced a wide range of types and sizes (although the very small production base meant that the total product range was extremely limited) and their products were of a low technical level, frequently representing insignificantly modernised, pre-Revolution models. Production technology was primitive, although some elements of serial production with use of jigs and fixtures were being introduced at the leading factories. Furthermore, progress in standardisation was very slight. As noted, the lack of a specialised trust was an important factor, but this itself was partly a reflection of the fact that the strategic role of machine tool building was not yet fully appreciated at a time when industrialisation plans were still in the process of clarification. Other factors were present. During the nineteen twenties there were few specialists with a knowledge of modern machine tool building. An exception was the staff of Orgametall, but at this time they had no direct links with machine tool building. Finally, the demands posed by the engineering industry were not as strict at this time as they were soon to become: such leading branches with respect to production technology as the automobile, tractor and aircraft industries were then in their infancy.

c) The Transition to Phase Two

The policy of the Five-year Plan as approved in May 1929 can best be seen by looking at not only the plan document, but also the related VSNKh work on the basic lines of technical reconstruction during the plan period. Specialisation of factories provided the key element of policy for the machine tool industry, but there were very clear reservations on the question of scale:

"Realisation of specialisation in this branch requires great circumspection in view of the diversity of types, the large number of models and the vast assortment. Specialisation is carried out here not by the enlargement of production units, but by fixing a definite, comparatively narrow specification for types and sizes at each enterprise and in preventing production in very small series with its attendant difficulty in obtaining accuracy and quality in assembly. With a diversity of types the enlargement of enterprises does not improve assembly...Therefore, parallel with the strengthening of basic factories (im.Sverdlova, 'Krasnyi Proletarii' and 'Dvigatel' Revolyutsii'), development at the remaining fifteen small factories is foreseen, with the provision of strict specialisation by type... The experience of German and American factories shows that in machine tool building the enlargement of the enterprise is not a factor predetermining the best results".¹

At the same time the Plan indicated that during the five years attention was to be focused on the building of the most commonly used types (khodovye), i.e. general-purpose machines². Thus the Five-year Plan presented a cautious view of the development of the industry and the specialisation of production, and did not provide for any real break with past practice.

A turning point in the struggle for a more radical policy for the development of the industry was the publication of the NK RKI survey in May 1929. This sharply critical review of the state of machine tool building outlined a number of measures for its improvement. Kaganovich, reviewing the survey's findings, called for a fundamental rationalisation and reconstruction of existing factories and the putting into practice in the first instance of narrow specialisation: "...the very same task which Professor Schlesinger puts before the German machine tool

factories; moreover, he sees this as the sole means of achieving the success of the present-day, North American industry... In our development of machine tool building we must emulate the American industry, both in relation to the structure of types built and its rate of development".³ As will be shown, these demands were to some extent contradictory. As practical measures NK RKI proposed the creation of a specialised trust, the freeing of factories from non-machine tool production and the specialising of each enterprise on the production of a single type of

1. Osnovnye linii tekhnicheskoi rekonstruktsii promyshlennosti SSSR, M., 1929, Vol. 2, p. 120.

The actual Plan was more cautious - the three main factories were to specialise on the 'most commonly met types and sizes', and no reference was made to the 'strict specialisation' of the small factories (Pyatiletnii plan..., op cit, Vol. 2, p. 15).

machine, the concentration of production of standard items (fasteners, controls, etc.) at specialised enterprises, and the development of production of such types as turret lathes, automatics and semi-autos.

As plan targets for machine building as a whole were steadily increased in the course of 1929, demands for a more radical policy for machine tool building intensified and found some reflection in the VSNKh decree of January 11th 1930. This called for intensification of work on new factories and led to a revision of their project capacities. With this revision the three new works, conceived as integrated machining-assembly factories, but supplied with castings from specialised foundries, were given a scale quite substantially greater than that typical in capitalist countries. The capacity of the milling machine works was raised from 1,300 units a year to 3,400; of the turret lathe factory from 1,200 units to 2,400. The former was projected for the building of horizontal, vertical and universal milling machines of four basic size groups; the latter for an annual output of 2,100 turret lathes of two basic sizes and 300 semi-automatic lathes.⁴ Thus the caution expressed in the VSNKh Plan guidelines of a year before with regard to scale was swept aside.

The three new factories were projected in Berlin, as related in Chapter 9. This naturally raises the question of direct German influence on the strategy of the industry at this time. There is no evidence of German advice on the broad issues of strategy, but this cannot be ruled out, especially if one takes into account the close links between Orgametail, Al'perovich's organisation before he joined Stankotrest, and German industry. It is known that Schlesinger was a consultant on a number of projects and in view of his direct links with the German machine tool industry it is quite probable that he expressed his views on the desirable course for the Soviet industry. Unfortunately his position on this question in 1930 is not known, but later in the decade he did set out his views in the Soviet press. "In relation to mass demand for machine tools", he wrote, "the USSR is in an unusually favourable situation - there is no country in the world

2. Pyatiletanii plan, op cit, pp. 156-157.

3. Ek. zhizn', 19.5.1929; original emphasis.

4. Vestnik metallopromyshlennosti, 1931, No. 8, p. 64.

where it is possible and necessary to put forward a demand for making several hundred thousand machine tools a year of the most diverse kinds...But there is a serious problem with regard to the skilled workers necessary for such a colossal development of production. As the creation of a skilled labour force entails great difficulties and the task cannot be solved in a short period, it is necessary to put production on a mass basis in order to increase it rapidly. In switching from the production of one hundred lathes a month to four hundred the working time is reduced by half. Consequently, with mass production, compared with the previous system of work, one needs only half the number of workers to make four hundred machines".¹

In order to raise productivity it was essential, he stressed, to eliminate all hand fitting, i.e. to secure fully interchangeable parts. Thus Schlesinger clearly had in mind the widescale use of jigs and fixtures in order to secure accurate work with relatively unskilled labour. Schlesinger was therefore proposing a strategy for the Soviet industry which represented an extreme version of the rationalisation policy pursued by the German machine tool in the 1920s. His starting point was a conviction that it would take a long time to train skilled Soviet machine tool builders. Only mass production technology would permit this obstacle to be overcome and, fortunately for the Soviet industry, the demand was so great that such technology could be employed. Although not spelt out, Schlesinger's policy also entailed very large, specialised factories.

Early in May 1930 many leading specialists of Glavmashinstroi responsible for policy and practice in the engineering industry, including machine tool building, during the preceding period were purged.² Shortly before this was announced an editorial of Izvestiya presented a vigorous plea for a new policy in machine tool building; the arguments strongly resembled those of Kaganovich and NK RKI. After stressing the vital role of the machine tool industry for securing maximum independence from capitalist countries, the defence of the Soviet Union and the further development of industry as a whole, the editorial called for the reconstruction of existing factories and the construction of about ten new, specialised enterprises. The branch had to be developed from scratch because virtually no machine tool building of note had been inherited from Tsarism. But:

1. ZaInd., 29.6.1936.

2. Izvestiya, 19.5.1930.

"The lack of any tradition in this field creates favourable conditions for at once putting this matter on a completely different footing than is the case in Western European countries and America. It is not necessary for us to create a vast number of small, isolated factories competing between themselves on the world market on analogy with European countries and America. Basing ourselves on the satisfaction of our own needs, we have the conditions for organising the mass production of machines of a single type. This is completely unrealisable for capitalist countries".¹

Machine tool building, the editorial admitted, was one of the most skill-intensive branches of engineering. Several hundred young skilled workers would have to be trained at foreign factories in order to provide the designers and setters for the new enterprises, foreign specialists would have to be engaged and several thousand skilled workers would have to be rapidly trained in special FZU schools. The three new factories, it stressed, had to be in operation by October of 1931 and alongside the building of standard machines for existing machine building factories they had to prepare for the production of modern special machines suitable for use in the mass production motor industry. Thus the argument resembled the later position of Schlesinger: the perceived scale of demand for machine tools, coupled with the absence of an already formed organisational structure, was seen as a sufficient condition for the adoption of very highly specialised mass production. At the same time it was acknowledged that machine tool building required high skills. The manner in which the building of specialised machines was to be reconciled with mass production of general-purpose models was not specified; the problem was not even recognised.

In July 1930 Kaganovich again spelt out his ideas on the strategy of development of the industry, referring as before to the American practice of machine tool building. The American industry, he wrote, was characterised by the existence of small enterprises producing on average one hundred units a year, with a maximum of up to three thousand units. Factories served a wide range of customers and had a low level of specialisation, but "despite" this the American machine tool industry played an exceptional role in equipping the mass production automobile industry and an active agent of technical progress. Kaganovich placed particular emphasis on the fact that American machine tool builders supplied fully

1. *Izvestiya*, 10.5.1930. (original emphasis).

tooled-up equipment for specific operations. This was a product of the close relations which existed between machine builders and users and this close collaboration was also observed in the high level of organisation of technical, design and research facilities in American machine tool factories. Thus, Kaganovich concluded, "American machine tool factories are 'factories of new technical ideas' for all branches of machine building and metal working".¹ The lesson for the Soviet industry, he concluded, was that machine tool building was to a great extent a qualitative problem. Practical policy conclusions were similar, but more far reaching than in the previous May. "In organising production it is necessary, with significantly greater boldness than in America and Germany, to specialise our production, limiting as far as possible the number of types and sizes of machine tools Without fail it is necessary to introduce flow production, organising it not only at the new enterprises but also reorganising the existing ones by this method". Finally, Kaganovich noted the great importance of training skilled personnel in view of the high skill demands of the branch.

So far we have primarily the policy proposals of NK RKI. In August 1930 the position of Al'perovich was clarified in a major article, significantly entitled 'to obtain a fundamental change in machine tool building'.² The industry, he acknowledged, was failing to meet demands both in terms of quantity and quality. The main task was to radically renew the design of machines built. During 1930-31 preparations were to be made so that all factories would be building new models in the following year. The three main enterprises and a number of smaller factories would be reconstructed by the end of 1930-31, and at these factories the range of machines built would be reduced to the maximum possible extent, providing a high degree of specialisation of production. A month later Al'perovich also took up the theme often stressed by Kaganovich, that machine tool building was not simply a matter of producing machines, but also providing customers with fully tooled-up technological processes.³

It seems clear that by early September 1930 the policy of the specialised

1. *ZaInd.*, 24.7.1930.

2. *ibid.*, 5.8.1930.

3. *Izvestiya*, 9.9.1930.

machine tool industry had moved a long way in the direction outlined by Kaganovich and NK RKI and this fact received official recognition at a session of the VSNKh Presidium early in the month devoted to the problems of the industry. At the session Al'perovich referred to the large product ranges of the branch's factories and the very backward design built. In 1930-31 output would double, but largely as a result of producing these old models.¹ VSNKh adopted a decree on the basis of Al'perovich's report, calling for a full transition to new models in 1931-32, and as a condition for the realisation of this programme it declared that, "Soyuzstankoinstrument must take a firm course for the specialisation of machine tool factories".² It was this decree which effectively marked the transition in practice to a policy of strict specialisation of factories on the basis of a reduced product range, signalling the end of the first phase of development of the industry.

Phase Two, September 1930 to June 1933

a) Policy

Some of the elements of policy during Phase Two have already been examined in the above account of the discussion leading to its adoption. The intention was to switch from old to new designs; the nomenclature of machines built was to be restricted and factories were to specialise on the building of a small number of types and sizes. As a consequence, the seriality of production would rise and this would permit the adoption of new production technology. The nature of this technology was not spelt out at the time, but it is clear that the widescale use of jigs, fixtures and special tooling was foreseen, securing interchangeable parts production. Furthermore, it is clear that the leadership of the industry saw the use of such methods as providing an answer to the acute shortage of skilled workers; machine tool building was to be deskilled. In February 1931 at a VSNKh Presidium meeting Al'perovich stressed the role of operational differentiation, typical of large-serial and mass production, in reducing skill requirements, giving the possibility of training workers in weeks or months as opposed to the years formerly necessary to train skilled workers.³ Although he did not refer

1. ZaInd., 12.9.1930.

2. ibid., 17.9.1930.

3. ibid., 13.2.1931.

directly to machine tool building in this connection , the argument clearly accorded with the policy of the branch.¹

With the adoption of the policy of strict specialisation of enterprises discussion did not cease: in 1931 demands were heard for an even more vigorous application of the principle. Some of these contributions will now be considered as they throw light on the conditions in which the actual development of the industry took place at this time, and also serve to elucidate both the logic and contradictions of this phase.

M.Sorokin of Stankoimport was adamant that the organisation and methods of capitalist machine tool building provided no model for the Soviet industry:

"To adopt the foreign experience of the German, American and British machine tool industry with respect to organisational-production matters would be to take as a basis obsolete forms pertaining to the conditions of an earlier stage of the capitalist system, and not to use modern technical achievements and the favourable factors of the socialist system..²

Under capitalism, Sorokin wrote, the adoption of progressive principles of specialisation and cooperation in machine tool building was hindered by the anarchy of production, competition between firms, the multitude of types and sizes and the small scale of factories. Furthermore, the majority of machine tool building enterprises had appeared long before the automobile industry and as a result had a backward, complex structure formed over a very long period. There was no reason , in his view, why such an irrational pattern had to be copied in the Soviet Union. In the conditions of the socialist planned economy wasteful excess product diversity could be avoided , he believed, by concentrating on the production of single types of basic machines - one type of universal milling machine, one type of radial drill, etc. "We can reduce the commonly used types of machine tools to a minimum and produce each of these types in a quantity sufficient to apply in the main the methods of mass production ".³ Furthermore, the planned economy gave the possibility of standardising parts and assemblies common to different types. Adoption of this principle, he declared, could lead

1. See Chapter 11.

2. ZaInd., 16.2.1931.

3. ibid.

to a 'literal revolution' in the practice of machine tool production and radically reduce costs. But while calling for far-reaching specialisation of production, Sorokin also demanded a transition from the production of predominantly general-purpose machines to specialised equipment of a high-productivity nature suited to the demands of mass and large-serial production. In his view, general-purpose machines would be needed in relatively small quantity compared with these more specialised types. Sorokin did discuss the possibility of creating more specialised machines by simplifying the basic universal models and by the adoption of the unit-construction principle but, nevertheless, he did not clarify the problem of reconciling increased specialisation of the products with greatly increased specialisation of production and the adoption of mass production methods.

One solution to this problem was put forward by N. Golosman (position unknown) in June 1931; he assumed that the demand for some of the high-productivity types would be so great that it would be possible to organise their mass production. This, he believed, would apply to the more commonly used types of automatics and semi-autos. Golosman, like Sorokin, favoured American types of machine tools as opposed to European, but believed that he had rather underestimated the role of simple, standard universal type machines in Soviet industry. There was no doubt in Golosman's mind that mass production methods had to be adopted for building the majority of types even though small or medium serial production was employed abroad. "There is no sense whatsoever," he wrote, "in our breaking up the Soviet machine tool industry into hundred of small factories. It is necessary to concentrate the production of the type of machine tools we need at powerful machine tool building giants on the basis of specialisation and cooperation".¹ The only path for the Soviet industry was, he believed, the building of "tens of powerful machine tool building giants".

The policy of mass producing machine tools continued to be advocated early in 1932. Sokolov, a leading specialist of the industry, wrote that :

"It is necessary for us to develop the large-serial production of machine tools of such design as will make possible the achievement of maximum productivity, high precision and automaticity in machining parts, coupled

1. ZaInd., 19.6.1931.

with simplicity of setting up and control. With mass production such a machine tool, being simple from the design point of view, will be cheap. This is why Soviet machine tool building, securing continuity of production flow, will differ profoundly from the patterns of development of machine tool building of capitalist countries".¹

But from the summer of 1932 statements of this kind became more infrequent.

So far we have not considered the views of Al'perovich during the Phase Two years. While he evidently supported the general strategy, in particular during late 1930 and 1931, it is also clear that his understanding of the tasks of the industry and the course of its future development was rather different from that of Sorokin or Golosman. On a number of occasions in 1931 he stressed that the most important task before the industry was the assimilation of the production of new models of modern design. Criticising Sorokin for putting one-sided emphasis on the building of specialised, high-productivity types, Al'perovich stressed that account had to be taken of the specific demands of the Soviet economy in the short run, one of the most important of which was that a very large quantity of general-purpose machines was required. However, he also acknowledged that more specialised types required by the auto-tractor industry would have to be built and noted that the new turret lathe factory was to build semi-automatics, while the new Gor'kii "giant" would produce "an enormous nomenclature" of standard and special milling machines.² Such a prospect was not really in accord with the policy of very narrow specialisation, but this problem was not at this time admitted.

By November 1931 Al'perovich appeared to have accepted a number of the propositions advanced by Sorokin and others, notably their analysis of capitalist machine tool building and the implications of this for the Soviet industry. Al'perovich sharply contrasted capitalist and socialist machine tool building, making no distinction between American and European practice. Capitalist machine tool building, he wrote, was carried out at relatively small enterprises; large firms like Cincinnati, Browne and Sharpe, Reinecker, Loewe and Herbert were exceptional. Even such prominent firms as Fellows, Raboma, Lang and Churchill had

1. Sokolov, A., *Sovetskoe stankostroenie*, M., 1932, p. 28.

2. *Za Ind.*, 14.4.1931.

only 300 to 800 workers in good economic conditions. Furthermore, the largest firms produced an 'extraordinarily diverse nomenclature of machine tools'. The conditions of capitalist production promoted an excessive product variation and a tendency towards a high degree of universality of machines built. Furthermore, standardisation was weakly developed and, Al'perovich claimed (contrary to his opinion four years before), the production of standard parts at specialised factories as widely practised in the motor industry was unknown to the machine tool building industries of Europe and America. What were the lessons for the Soviet industry? First, "The exceptionally large demand for certain types of machine tools gives us the possibility of creating new factory-giants for individual types with the organisation of large-serial production".¹ Second, while the Soviet economy needed universal machines, an ever increasing share of the equipment required by industry would be of a more specialised nature. Third, the planned economy gave the possibility of far-reaching standardisation of parts and the organisation of the production of standard items, and castings and forgings, at special factories. Looking to the future, Al'perovich envisaged the building of a further twelve new factories; at these and the existing enterprises over three hundred types and sizes would be built, including specialised types suited to the demands of large-serial and mass production. This contribution of Al'perovich was basically in line with the policy of Phase Two with the proviso that this was the first occasion on which such a large future tipazh had been foreseen. Clearly, given such an expansion of the product range, the building of new enterprises was essential if the principle of narrow specialisation was not to be eroded.

In 1932 the transition to a revised strategy began; old positions were reassessed partly in response to the practical experience of the industry since 1929

b) The Transition to Phase Three

The year 1932 was to be the year of transition to new models and the commissioning of the two new enterprises. In January 1932 Al'perovich gave the first real indication that all was not well with the fulfilment of the new models programme.

1. SI, 1931, No. 11-12, p. 3.

"As a rule under pressure to fulfil the quantitative output layed down by the programme for old models", he complained, "factories very badly lag in relation to design work, but still more in relation to the technological preparation of machine tools of new design".¹ This backwardness was serious in view of the fact that 1932 was to be a year of preparation for the forced development of machine tool building during the Second Five-year Plan; initial indications were that machine tool output would have to increase eight-fold during the next five years in order to meet the demands posed by the engineering industry. In February Al'perovich presented the tasks of the coming period in more concrete terms. The primary aim was that of securing technical independence; this required a fundamental change in the tipazh of produced machines. By the end of the five year period the share of lathes in total output would have to be reduced to only 20 per cent, while the proportion of grinding machines would be 18 per cent, and of turret lathes, automatics and semi-autos 16 per cent.² In the near future at least 150 types and sizes would have to be assimilated.

The slow pace of assimilation of new models caused mounting concern in the spring of 1932. A meeting of the collegium of NKTP in early April singled out the introduction of new models as first priority for the branch and Ordzhonikidze spoke in favour of putting quality before quantity - the industry was not to fear a possible reduction of output while assimilating the new models.³ The main reason for the slow progress was the delay in making jigs, fixtures and special tools required for the building of the new machines. This was admitted by Al'perovich in a major article in April, notable because it was the first occasion on which the question of the technological preparation of production was raised as a major issue. Al'perovich contrasted conditions abroad and in the Soviet industry:

"In our conditions the role of special tooling and fixtures for the production high-grade machine tools acquires particular importance. In capitalist countries there are cases of the production of high-class machines at small factories where all production is based primarily on highly skilled workers. This has an especially large place in British machine tool building factories and to a lesser extent in Germany and even in the United States. We have to

1. SI, 1932, No. 1, p. 1.

2. ibid., 1932, No. 2, p. 2.

3. ZaInd., 6.4.1932.

take account of the basic fact that all our factories, not just the new, but also the existing ones, have an extremely low level of labour skills. The average wage rate coefficient for the ob"edinenie as a whole on 1st January 1932 was 1.46 - 1.47 and the average grade of workers was about three. Even in the toolrooms there are hardly any workers of grades seven and eight. Under these conditions one cannot expect to obtain accurate dimensions determining the quality of machine tools on the basis of highly skilled boring and planing machine operators and assembly workers. The output of machines corresponding to modern demands may be secured only by previously made templates, jigs and gauges".¹

Thus it was considered that the acute scarcity of skilled labour made necessary the adoption of capital intensive production methods relying on jigs and fixtures as the only means of securing the requisite quality of work in building machine tools of modern design. The full implications of this resort to elaborate tooling do not appear to have been appreciated at this time.

On 1st June 1932 the NKTP order No.407 was issued.² This amounted to a call for a change of course in the development of the industry in so far as it required Stankooob"edinenie to begin the production of specialised machines required by the auto-tractor industry. The building of grinding machines, automatics, semi-autos and gear-cutting machines was to have first priority, while heavy machine tool building was also to be developed. Plans for individual enterprises were to be revised with a view to increasing the share of new models. More factories were to be involved in machine tool building and new enterprises^{constructed} for the building of grinding machines, gear-cutting machines and heavy machine tools.³

The implications of the order were discussed at the First Conference of Machine Tool Designers in July at which Al'perovich delivered a major report on technical policy. This report has particular significance because it appears to have been the first public occasion on which Al'perovich criticised excesses in the practical realisation of the specialisation policy of Phase Two. Experience showed, he began, that it took $1\frac{1}{2}$ to 2 years to produce new models from the time of preparation of working drawings. During the Second Five-year Plan the industry would have to assimilate over a hundred new types and sizes; hence there was a considerable volume of design and preparatory work to be undertaken. Furthermore, the structure

1. SI, 1932, No. 4, p. 2.

2. For the background to this order see Chapter 7, p. 250.

of types built would fundamentally change. Turning to the problem of factory specialisation Al'perovich outlined the new situation:

"Of course, it is easier to find a common language at a conference of designers because among design workers one is unlikely to come across many such lovers of specialisation who would strive to carry it to absurdity, with a factory stamping out one and the same machine tool for years on end. This contradicts both the professional interests and the pride of the designer.. The real solution lies somewhere between the interests of the designer and the interests of the productionman, who is inclined to show more conservatism with regard to retaining the stability of machine designs and the possibility of having less types and sizes at his factory. We have worked out the specialisation of machine tool factories for our pyatiletka ... A perspective plan that we will have 'n' number of factories and that we will give a limited number of types to each factory is one thing, but the realisation of specialisation during the Five-year Plan is another matter. ..We are unable to build all the factories at once, but we cannot wait for some of the machine tools intended to be built at these new factories.. If we have no special factory of ,say, tool and cutter grinders or other machine tools , this does not mean that we shall not force some factories to make these machines for fear of breaching the principle of specialisation, Here we must show considerable flexibility. In many cases it will in practice be absolutely necessary , using the existing production base, to prepare the production of those machines which we will strive to supply at future factories.. together with a clear plan of specialisation of factories during the Five-year Plan , we will have to have a much more diverse nomenclature of production of machine tools at our existing base than individual factories will want".¹

This statement amounted to a major revision of the policy of Phase Two; further evidence that this was the case was provided when Al'perovich again turned to the question of the preparation of production. On the basis of practical experience he modified his previous position, admitting that different types of machine required different degrees of tooling: "If a machine is so well established and the country needs it in such large quantities that we can say without any risk that it can be made without fundamental changes in a quantity of 5-6,000 units as is the case with the 'DIP'", then this justified a high degree of preparation, but the situation was quite different if a machine was to be built in hundreds and was liable to undergo design changes. Al'perovich admitted that mistakes had

3. *SiI*, 1932, No. 7, p. 2.

1. *Ibid.*, 1933, No. 1, p. 2.

been made ,e.g.the 'Komsomolets' factory was making elaborate technological preparations appropriate to an output of several thousand units for the building of its combined machine tool even though it would be obsolete by the time it was in full production in one and a half to two years time. Thus,Al'perovich continued:

"What follows from this? From this it follows that machine tool building has its own laws. These are machines which as a rule do not have a chance of a long existence without fundamental changes. Therefore , as a rule, technological preparation for machine tools cannot be based on the making of a large number of units of machines without any design changes; true, with some exceptions".¹

New machines ,he concluded, had to be made much more quickly with the use only of the most important and simple fixtures, as was the practice of European and American machine tool building. On this occasion no reference was made to the question of labour skills.

The conference of designers can be seen as an attempt to mobilise the new and relatively inexperienced design forces in support of a new policy for the industry : a transition from the large-serial production of general-purpose machines at factories specialised on the building of a very narrow range of types and sizes,to the production of a much broader product range covering specialised high-productivity types to be built in smaller quantities and necessitating, at least in the short run, some despecialisation of enterprises. As Al'perovich made clear,such a new policy was contrary to the interests of those concerned with production - they had a vested interest in the maintenance of the policy of Phase Two.

Despite the NKTP order and the conference of designers in July there appears to have been no real change in practice in 1932. All the factories were at this time grappling with the problems of assimilating new machines of a much higher technical level than any built previously. Provisional outlines of the next Five-year Plan still provided for a very substantial increase of output by 1937 - to 70 - 80,000 units, or over four times the 1932 level. But from the beginning of 1933 the pace of development quickened. Following the January combined Party Plenum output targets for the industry were progressively reduced and at the

same time the pressure for import substitution intensified. Meanwhile, although factories were still experiencing problems in assimilating new types, performance was beginning to improve and at a number of factories the cost of new machines was starting to fall.¹

In May 1933 a delayed issue of Stanki i Instrument carried a major editorial by Al'perovich, significantly entitled, 'A turning point', apparently written following a conference of managers of Stankoob"edinenie factories. This conference, claimed Al'perovich, had shown that the overwhelming majority of managers and technical leaders continued to hold outdated views on the tasks of their factories and had not translated the directives of the January Plenum "into the language of machine tool building". The latest outlines of the Second Five-year Plan showed a sharp reduction in the ob"edinenie's target - it now stood at only 15,000 units for 1937. The new situation was reviewed:

"..the question of removing from import a whole series of modern machine tools previously not made in the Soviet Union is becoming all the more acute. The question of independence from capitalist countries in machine tool building has recently become much more acute and urgent. But the machine tool equipment of the country, its defence capacity and independence are in the first place determined by embracing a much broader nomenclature of machine tools, both by types and sizes, than has been the case to date. A number of recently revealed most acute needs of a whole range of branches within heavy industry (and outside it) and also the revealed needs of the defence of the country, demand an immediate and most rapid expansion of the produced nomenclature of machine tools".²

Al'perovich then proceeded to condemn the "backward views" of managers, including the "intolerable" attitude that, "one can make one and the same machine in unlimited quantity and for an unlimited number of years". The factories, he stressed, had not become "laboratories of technical thought"; they did not take account of the needs of users and they showed "extraordinary conservatism" in relation to design changes. He acknowledged that an important factor determining such behaviour was the condition of the market, which led customers to take any product regardless of its quality or price. Now some factories were seeing the first signs of difficulty in selling their machines and in Al'perovich's view

1. ZaInd., 6.4.1933.

2. SiI, 1933, No. 4, p. 1.

this was to be regarded as an "absolutely positive phenomenon", forcing factories to take more account of the demands of customers.

From his analysis of the new situation Al'perovich drew certain conclusions for the development of the branch. First, the range of machines built had to be rapidly expanded and this required an acceleration of the pace of preparing and assimilating new models. Second, it would be necessary to expand the range of machines built by each enterprise and switch in many cases from the principle of narrow specialisation and large-serial production to the principle of producing in small and medium series. Third, it was essential to involve more machine building enterprises in machine tool building, given the existence of a single guiding centre for technical and design leadership. This new path, he acknowledged, had a number of implications for production organisation and methods:

"The transition in many cases from large-serial production to small serial and in certain cases even to individual production will force many factories to refrain from the previous scale of technological preparation; from that colossal number of special fixtures and tools which were resorted to with the orientation to making one and the same machine in unlimited quantity. If previously minds were set at ease by the possibility of replacing the needed skilled workers by complex special fixtures, then with the complication of the product range and transition to small-serial production the problem of the skills of workers and middle-range technical personnel acquires particular acuteness. In relation to the really scarce skills we will have to seriously retrain both workers and technicians".¹

But there was an additional method of tackling the problem of widening the product range which also had to be adopted: maximum standardisation of parts and assemblies, securing the possibility of raising the seriality of production of individual assemblies common to different models. Finally, Al'perovich expressed confidence that the industry would be able to successfully meet the new challenge, because during the three years of existence of the specialised industry the main gain had been the acquisition of the skills necessary for both designing and making modern, complex machine tools.

It is clear that from June 1932 Al'perovich, apparently with the support of concerned NKTP leaders, was engaged in a struggle to convince the leading workers of the machine tool enterprises of the necessity of a change of course. The

order of June 1932 was a first step, but it was couched in general terms and the full implications of the demand for a broader product range had not been grasped at that stage. Al'perovich's article of May 1933 posed the new situation and its implications for the path of development of the industry much more sharply and concretely. The next stage in the process of changing course occurred in June 1933: on the 16th NKTP issued a new order (No. 557), signed by Ordzhonikidze, which formally laid down policy for the industry during the Second Five-year Plan period.

The order, 'On the development of machine tool building', after reviewing the achievements to date, noted that the main bottleneck in the development of the industry was, "the extreme narrowness of the nomenclature of produced machine tools", which had necessitated large scale imports. Furthermore, the domestic industry built predominantly universal type machines. The main points of the order were as follows. First, Stankoob"edinenie was to secure the organisation of production of at least 200 types and sizes of new machine tools in addition to the 40 then in production. Second, first priority was to be given to the building of grinding, gear-cutting, vertical turning and boring machines, automatics, and semiautomatics, including multi-spindle models. Third, the technical level of machines was to be raised, with the development of electrification and hydraulics. Fourth, Stankoob"edinenie was to review the plan of specialisation of factories to provide a sharp expansion of the number of types and sizes made at each. Sixth, machine tool building outside the specialised industry, at the 'planned enterprises', was to be further expanded.¹

Following what appears to have been standard practice for the branch, the appearance of the new order was followed by the convening of a conference of representatives of the industry, both specialised and 'planned'. The First All-Union Conference on machine tool building took place from June 20th to the 22nd. The main opening speeches were given by M. Kaganovich and A. Pudalov of NKTP. The former criticised the conservatism of factories and their reluctance to take on new work; this was unfavourably contrasted with practice in capitalist countries where the market and its demands were carefully studied. He also attacked the

1. StI, 1933, No. 7, pp. 2-3.

complacency of managers who had succeeded in assimilating the production of new machine tools in the preceding period and now showed no concern for introducing further new models. While the primary purpose of the conference was to discuss practical problems of implementing the order and, in particular, of involving the 'planned' factories, the general question of strategy for the industry was raised by Al'perovich in his speech, and the subsequent discussion was diverted from its main object by a bitter clash on policy between Al'perovich and the young engineer, G. Shaumyan, then a worker of the institute, NIISTI.

In his report to the conference Al'perovich defended the past policy of the industry. In the previous period, he explained, all the attention of the industry had been focused on mastering the techniques of machining the basic machine tool components. This in his view was part of the answer to those who accused the industry of paying too much attention to universal machines to the neglect of more specialised types:

"In my opinion it is necessary at each specific stage of development to concentrate attention on the central, crucial problem. In 1932 the central problem was the question of teaching people to machine parts of machine tools. It is no secret that at our new factories, having collectives of 1,500 workers, we had not one man who had built machine tools at any time in the past. There was no point in dreaming of creating our own designs until we had mastered simple production tasks. This would have been empty talk rather than a serious approach. Therefore we put the problem of a sharp expansion of the nomenclature before all our factories with great force at the beginning of 1933, and not in 1932. After thousands of people had undergone courses of study and learning on the job, and had learnt to machine the parts of machine tools, we were obliged to demand that they did not get carried away with the mass output of one and the same machine, and that they thought about the fact that they are a hotbed of technical thought... At the start of 1933 we posed this problem with great force before all our factories and we have already had a change in this direction. We have already fundamentally changed the psychology of all our factories".¹

Turning to the question of labour skills, Al'perovich admitted that their previous view had been mistaken and that a "serious correction" had to be made:

1. Stenogrammy - pervogo vsesoyuznogo soveshchaniya po stankostroeniyu, 20-22 iyunya, 1933g, n.d., (duplicated), pp. 27-28.

"We were temporarily carried away by our achievements during last year when we worked with complex fixtures for all basic operations; carried away to the extent that we believed we could have a skilled boring machine operator within two months, who could within four months become an instructor in boring".¹

There had been considerable achievements using these methods, he declared, and they would continue to be used in the future, but for making many different types of machine tools complex fixtures could not be used and therefore a higher degree of skills would be required. Thus Al'perovich was not envisaging a complete rejection of previous practice, but modifications to meet new demands. This fact became clear in the clash with Shaumyan.

Shaumyan regarded the conference as a positive development but, nevertheless, thought that certain workers of the industry (probably meaning Al'perovich and other ob"edinenie leaders) were still not sufficiently aware that a 'turn' had been reached. His demand can be summarised in his own words: "From machine tool building of mass and large serial production, to machine tool building of small serial and individual production".² Shaumyan was scathing about the fact that the 'DIP' was to be built in a quantity of up to three thousand units a year, and that the turret lathe factory was taking the same path of "mass production", with corresponding provision of tooling. This provoked an intervention by Al'perovich, who enquired how the turret lathes were going to be built without the use of jigs and fixtures. To which Shaumyan replied: "In my view, if we want to train cadres, then precisely for this reason it is not necessary to introduce mass production at all, but is necessary to organise individual production".³ In his reply to the discussion Al'perovich again defended the past policy of the industry and rejected Shaumyan's argument:

"Our job is not to produce one example each of three or four types of machine tools so that the press will write that we are heroes. We shall not take that path. It is necessary to master the technology of making machine tools. The production of individual models regardless of cost and quality does not amount to "mastering technology". I say that neither in its actions, nor in its policy has machine tool building committed any errors of principle".⁴

1. *ibid.*, p. 29.

2. *ibid.*, p. 65.

3. *ibid.*, p. 66.

4. *ibid.*, p. 86-3.

On the question of the use of fixtures , Al'perovich stressed that it depended entirely on the quantity of machines to be built. It would not have been possible to produce the 'DIP' without wide use of jigs and fixtures , and it was only because this method had been adopted that the industry had quite rapidly mastered technology. Furthermore, he added a justification for the policy of the First Five-year Plan of concentrating on universal machines:

"We had to begin production of machines having wide use, which have wide sales and justify the use of many fixtures. If two years ago anyone had forced us to make all sorts of individual and special machine tools for the auto-tractor industry we would not have had a machine tool industry; but now we must move forward by all ways and means".¹

In taking this line at the Conference Al'perovich was restating a position he had taken at a meeting held shortly before at the Club im.Dzerzhinskogo. On this occasion he had criticised what he regarded as two incorrect policies with regard to the technological preparation of production: the first, the view that machine tool building was distinguished above all by the fact that it catered for the specific demands of customers so that machines had to be built on a small serial or individual basis; the second, that one could adopt the methods of technological preparation appropriate to mass production as in the auto-tractor industry. The first line was incorrect, he declared, because it ignored the fact that there was still a large demand for "so-called 'universal' machine tools", which could be made on a serial basis with an appropriate degree of tooling. The second line had been an "infatuation" on the part of some engineering and technical workers of the branch during the first years of its development : it had delayed the output of new machines and involved considerable expense. It was essential, Al'perovich had stressed, to always take account of the possibility of design changes. It was rare , he acknowledged, for factories to make any calculation of the cost of fixtures or estimates of their economic justification: the decision to use fixtures was frequently not taken just because of the complexity of parts and processes, but because of the lack of skilled workers.²

1. *ibid.*, p.86-4.

2. *Predpriyatie*, 1933, No. 13, pp.35-36.

While the new policy entailed a major shift of emphasis for the industry it by no means meant that the aim of securing a high degree of seriality of production wherever possible had been rejected. At the conference Al'perovich stressed that the branch was committed to a policy of standardising parts and assemblies to the maximum possible extent. In his pre-conference speech he elaborated on why this was essential for the Soviet industry: the aim was to secure the benefits of large-serial production even though the product range was widening. Standardisation of such parts and assemblies as pumps, gearboxes, tool rests and feed boxes would permit a higher seriality of production even if the basic products of a machine tool enterprise were built on a small serial basis. Furthermore, it would give the possibility of greater flexibility in building special machines. Al'perovich also noted that the creation of 'typical' (tipovoe) or 'standard' machine tools of general-purpose would also facilitate the organisation of large serial production for a period of time justifying proper technological preparation.

Shortly after the Conference Al'perovich again defended the policy of Phase Two as being correct in the circumstances - as a result the basic skills of machine tool building had been learnt. On this occasion he also defended the building of very large new enterprises during the First Five-year Plan. Capitalist machine tool building firms were typically of 300-600 workers; they tended to have equipment of a low technical level and small serial production based on very highly skilled workers. But, "For the Soviet Union such a method of organising its own machine tool building base, moreover in a very much shorter time than was the case in the industrial capitalist countries, was out of the question. We were not able to use a single enterprise of Europe or America as a model".² The few

1. Predpriyatie, 1933, No. 13, p. 36. Note, in making this proposal Al'perovich was taking up an idea earlier propagated by Sorokin. In 1931 Sorokin had proposed that Soviet machine tool designers should create 'basic' types of machine ('bazisnye' - this was apparently the first use of this term which subsequently became part of the vocabulary of Soviet machine tool building). Such basic models for each of the main types of machine tool would serve as the foundation for a whole series of models differing by size and function with a high level of unification of parts and assemblies between the different variants. Furthermore, designers, he believed, should adopt the principle of 'stepped sizes' ('stupenchatost''), i.e. the creation of standard size ranges of basic machines ('brothers', as Sorokin termed them) on the basis of the unification of parts and assemblies. This was apparently the first clear call for the creation of what later became known as a 'gamma' of machine tools - see Sotsialisticheskaya rekonstruktsiya 1 nauka, 1931, Vyp. 2, pp. 115-127.

2. Planovoe khozyaistvo, 1933, No. 7-8, p. 51.

large factories existing in the West tended to be unspecialised, and "We were also not able to take the specialised factories of Europe and America as prototype because they could satisfy us neither by their volume of production, nor by their production methods". He then went on to note that the industry had received no foreign technical assistance and described the inability of the Cincinnati company to assist in the building of the new Gor'kii factory, because its proposed scale was considered too great and the labour skills of Soviet workers were thought to be too low.¹ However, while defending past practice Al'perovich did not make clear whether he believed such large factories to be appropriate in the future, in changed circumstances. This question was to be clarified in the coming period.

The events of June 1933 marked a turning point in the development of the Soviet machine tool industry but, as will be shown, discussion on broad strategic issues did not cease. However, before examining the policy discussions of the Second and Third Five-year Plan periods, it is necessary to briefly consider the salient features of the practice of Phase Two.

c) Practice

The main elements of the strategy of Phase Two were the specialisation of factories by product, a restriction of the product range and a raising of the seriality of production. The aim was to secure a rapid increase of output and a reduction of the cost of machines built. At the same time new modern designs were to be introduced, replacing the models of the 1920s. The practical outcome of the adoption of this strategy can be considered by taking the industry as whole, and also by taking individual cases in which the policy was put into practice with particular vigour.

Before pursuing strict specialisation by type of machine the enterprises of Stankoob"edinenie had first to be freed from non-machine tool production. This was achieved during the First Five-year Plan period: the share of such production in total output of the specialised enterprises fell from about 45 per cent to

1. See Chapter 9, p. 339.

nil, with the exception of some consumer goods¹ (then produced by most factories of heavy industry).

The specialisation of enterprises by type of machine tool was indeed pursued with vigour in 1931, following the VSNKh decree of September 1930. From 1928/29 to 1929/30 the seriality of production rose sharply, although the product range was not reduced, mainly as a result of the taking up of reserves and the reduction of non-machine tool building activity. But in 1931 the number of types of machine built at the leading enterprises declined, leading to a dramatic increase in the average output per model compared with the previous year. In 1932 and to an even greater extent in 1933, with the introduction of new designs, the number of models again rose and the seriality of production fell back to the level of 1929/30. These processes are shown in the following table:

Table 4.1

The Specialisation of the Main Stankoob"edinenie Factories and the Seriality of Production, 1928/29 - 1933

Enterprise	1928/29	1929/30	1931	1932	1933
	T/M (S)	T/M (S)	T/M (S)	T/M (S)	T/M (S)
'Krasnyi Proletarii'	6/7 (87)	3/5 (250)	1/2 (1095)	1/3 (793)	2/6 (367)
im.Sverdlova	4/4 (75)	6/6 (87)	2/2 (303)	3/3 (158)	4/5 (n.a.)
im.Lenina	4/5 (161)	4/6 (248)	4/8 (432)	4/8 (275)	3/7 (238)
'Samotochka'	2/2 (78)	2/2 (172)	2/2 (379)	2/3 (244)	2/3 (262)
im.TsK.Mash.	3/4 (145)	2/3 (328)	1/1 (1485)	1/2 (n.a.)	3/4 (n.a.)
'Komsomolets'	2/2 (54)	2/2 (131)	3/3 (155)	3/3 (n.a.)	3/3 (139)
Total (average)	21/24 (106)	19/24 (202)	13/18 (498)	14/22 (329)	17/28 (237)
Av. per enterprise	3.5/4.0	3.2/4.0	2.2/3.0	2.3/3.7	2.8/4.7
Total inc. two new ents. in opn. from '32				16/24 (305)	20/32 (222)

T - number of types built (i.e. basic type groups - lathes, drilling machines, etc.)

M - number of models built (note - number of sizes not available)

S - seriality, defined here as average number of units built per model in year.

Source: compiled from Table SA.XIII.

1. Kholmyanskii, I, Spetsializatsiya i kooperirovanie mashinostroeniya v pervoi pyatiletke, M.-L., 1933, p.31. The primary non-machine tool building activity was diesel engine building at 'Krasnyi Proletarii' - this was phased out in 1931.

It can be seen that while the level of specialisation of the main enterprises (notably 'Krasnyi Proletarii' and im.Sverdlova) was raised in 1931, the limited size of the production base of the industry prevented the attainment of the aim posed by some of restricting each factory to a single type: this was achieved at two enterprises building lathes, resulting in an average output per model of over one thousand units - a remarkably high level by the standards of even the German machine tool industry. However, the types built by other enterprises tended to be related by size, weight and production technology.

The specialisation of production permitted an extremely rapid increase of output at these six leading enterprises: from 2,552 units in 1929/29, to 4,849 units in 1929/30 and 8,962 units in 1931. With the switch to new models in 1932 output fell to 7,246 in 1932 and 6,207 in 1933. Output would have fallen substantially more if production of some basic old models had not been maintained at a high level during the years of transition to the new product range, and it was precisely the specialisation drive of 1931 which permitted this maintenance of output.

The rapid ^Pexpansion of output and rise in seriality was attended by a very marked growth of the labour force of the specialised industry - from 4,170 workers in 1928 to almost 13,500 in 1932. The nature of the intake of new workers (mainly unskilled young people from the country) and the problems of its assimilation are discussed in Chapter Eleven.

With the adoption of the policy of Phase Two expectations with regard to the possible attainable output from existing and new enterprises rose by leaps and bounds, in part as a result of the counter-planning movement which developed vigorously in 1930 and 1931. The envisaged maximum project capacities of enterprises reached their peak in early 1932, and then gradually declined with the transition to Phase Three, falling back to the 1930 level by 1936. This process is shown in Table SA.XXVII. It should be noted that the extra output was to be obtained by specialisation and other organisational measures, including greater use of shift work than envisaged in 1929 and early 1930, and not by expanding

capacity by further investment.

Assessment of the policy of Phase Two in economic terms is difficult because of the lack of appropriate data. Cost reduction statistics are inadequate and the benefits derived from raising the seriality of old models cannot be determined because of the impact on costs of the assimilation of new designs. Expectations with regard to cost reductions were certainly high : a target of a 19 per cent reduction of cost of production was set for 1931; in fact costs rose by 4.4 per cent. At the im.Sverdlova factory alone costs rose in 1931 by almost 50 per cent, compared with a planned reduction of over twenty percent , owing to problems of assimilating new models.¹ However, the average value per unit of machines built fell to its lowest level in 1931 - 2,064 rubles per unit , compared with 2,734 in 1928/29 (specialised industry only), before rising very sharply in 1932. Despite the influx of new workers the output per worker in unit terms reached a level of 0.75 in the year 1931 , compared with 0.61 in 1928/29 ; a level which was not to be attained again until 1938. Productivity fell, however, in value terms , because of the low value per unit of machines built.²

The results of implementing the policy of Phase Two can also be seen by examining two particular enterprises where it was applied with unusual thoroughness, probably because the products in question , lathes of a relatively simple, general-purpose type having very wide use in many sectors of the economy, were well-suited to large-serial production. Possibly the most successful application of the policy was not at a factory of Stankoob"edinenie , but at the Izhevsk factory of the armaments industry . In 1930 this works was given the task of producing the maximum possible quantity of machines in the shortest possible time in order to reduce import dependence while the new factories were under construction. From the beginning of 1931 the factory began to prepare the production of the 'Udmurt' model, based on an 'American Tool' design. In order to train workers and maintain output while the new model was being assimilated, it was decided to force the production at the same time of a relatively simple lathe of 'Loewe' design.

1. See Chapter 13.

2. See p.424.

By May 1931 the factory was building 125 units a month of this model. The 'Udmurt' was to be built on a large-serial basis with the use of a large quantity of fixtures and special gauges, even though there was no experience of such a scale of production either in the Soviet Union or abroad. As the authors of a review of the factory's work in the First Five-year Plan pointed out, the majority of foreign machine tool factories worked with few fixtures, relying on highly skilled workers:

"This, in the first instance, is a consequence of the specific features of the capitalist economy, therefore for us in the conditions of a planned economy such a solution was incorrect. Besides this, the lack of highly skilled labour forced us to firmly take the path of widely using the methods of large-serial production. Taking this path, we significantly complicated the process of preparing and assimilating production, but on the other hand we have secured the possibility of very widely employing low-skilled labour (grades 3 and 4) and we have created a basis for a rapid growth of labour productivity and a cheapening of the machine tool in the future".¹

The first prototype of the 'Udmurt' appeared in May 1931, by January 1932 production had reached 60 units a month, by October 150 units a month, i.e. a rate of 1,800 units a year. This model remained in production throughout the Second Five-year Plan.²

The second case is that of the 'Krasnyi Proletarii' factory. The original plan for the reconstruction of this factory in 1925 had foreseen an eventual capacity of 1,585 units of twelve different types.³ By 1927 this had been revised to 1,760 units of six types.⁴ After the NK RKI survey plans were again revised to allow for an output of 2,325 units of five different types,⁵ but in early 1930 this was radically revised to 3,400 units of only one type, lathes.⁶ By the April 1931 an output of 4,000 units in 1932 and 6,000 units in 1933 was foreseen, with the DIP lathe as the sole model.⁷ In 1928/29 the factory in fact built about 600 machines of six different types and in the following year 1,249 units of three types. The year 1931 saw a fundamental change: 2,190 units were built of only

1. Volkova, L.K. and Perevalov, E.M., Za sovetskoe stankostroenie, Izhevsk, 1933, p.30.

2. ibid., pp.10 and 30.

3. Lebyachenko, op cit, p.8.

4. Aizenshtadt and Chikhachev, op cit, p.168.

5. Lebyachenko, loc.cit.

6. ibid., p.9.

two models, the TN-15 and TN-20 , somewhat modernised pre-Revolution designs. The relative simplicity of these models allowed their large-serial production without very extensive use of special jigs and fixtures and without the adoption of flow organisation.⁸ The new 'DIP' model , however, was from the start intended for very large serial production with technological processes devised for an annual output of up to 3,000 units.⁹ A considerable quantity of jigs, fixtures and special tooling was made in order to deskill machining operations, which were on a very much higher level of precision than for any previous models. Whereas 85 fixtures had been used for the TN-15 , 800 were required for the 'DIP'. In tooling up production of the new model the factory drew on experience of large-serial production acquired in diesel building.¹⁰ Output of the 'DIP-200' rose from 25 units in 1932 to about 500 units in the following year, and the overall level of output of the factory was maintained during this period of assimilation by building the older TN-20 model in growing number, its output reaching 1,302 units in 1933.¹¹ As a result of the adoption of the policy of Phase Two output per worker at 'Krasnyi Proletarii' rose by more than half in 1931 compared with 1929/30 , but by only ten per cent in the following year with the transition to building the 'DIP'. Furthermore, in 1931 the output per worker in unit terms reached the very high level of 1.42 ; this was not to be attained again in the pre-War years. Finally, during the 1929/30 to 1932 period the number of workers employed at the factory rose by 2.5 times , the majority of the newcomers having¹² no previous experience of machine building. By the end of 1933 'Krasnyi Proletarii' was firmly set on the new path of Phase Three. The number of models built doubled compared with the previous year and included a gear-cutting machine of modern design and a multi-tool lathe suitable for work in the auto-tractor industry.

7. Dokumenty trudovoi slavy Moskvichei, 1919-1965, M., 1967, p.130.

8. Machinery, 16.7.1931, p.497. Report of a British visitor.

9. SiI, 1933, No.10, p.6.

10. ibid.; Slavnye traditsii, op cit, p.24.

11. See Table SA.XIII.

12. See Chapter 11.

Phase Three, June 1933 to 1941

a) Policy

In the second half of 1933 and in 1934 there were no notable speeches or articles on the question of overall strategy for the machine tool industry. Commentators and leaders of the industry were primarily concerned with the realisation of the policy adopted in the summer of 1933, and while there was considerable discontent with the practical work of the branch, notably in relation to the rate of assimilation of new models and the supply of castings, the general line of development was not questioned. As the demands of the auto-tractor branch were clarified and imports were further reduced in 1934 the need to expand the production base by involving more engineering factories of other branches was stressed on a number of occasions, in particular by M. Orentlikher, now an NKTP official.¹ Orentlikher argued for making the fullest use of existing GUSIP enterprises, restricting the construction of new enterprises to capacity for heavy machines, automatics, grinding machines and special machines. In his view the main specialised factories required more vigorous despecialisation in terms of types built by each. In November 1933 he argued for splitting 'Krasnyi Proletarii' into shops for lathes and vertical turning and boring machines; Gor'kii into shops for milling and gear-cutting machines, and im. Ordzhonikidze into separate shops for turret lathes and automatics. As a short term measure he even proposed importing machine tool parts from foreign firms until new capacity could be introduced.²

The Second Five-year Plan as adopted in 1934 provided for the construction of five new enterprises to be completed by 1937. These were for the production of grinding machines (two), gear-cutting machines, automatics and heavy machine tools. They were to be large factories, with project capacities of 3,000 and 2,000 units a year for the grinding machine works, 2,000 for the automatics factory and 1,500 units for the grinding machine factory.³ Thus the policy of building enterprises of a larger scale than usual in other countries was retained. In May 1934 Al'perovich

1. ZaInd., 12.11.1933; 15.12.1933; Vestnik metallpromyshlennosti, 1934, No. 11, p. 72.

2. ZaInd., 12.11.1933.

3. Proekt vtorogo pyatiletnego plana..., op cit, prilozhenie, Osnovnye ob'ekty kapital'nogo stroitel'stva..., pp. 48-49.

once again defended the policy of building large machine tool factories and organising large scale production during the First Five-year Plan, justifying it as before on the grounds of lack of skilled labour.¹ On this occasion he also noted that while the auto-tractor industry was now the determining factor in the technical development of the branch, universal machines were still required in a quantity permitting serial, but not mass, production.

In 1935 questions of general strategy once again came to the forefront and old positions underwent further reassessment. Two main factors were instrumental in provoking renewed debate. First, as related elsewhere, concern over the rate of technical progress in the capitalist countries led to pressure for more intensive technical development in the Soviet industry and, second, the demand for high-productivity, specialised equipment rapidly increased, primarily for the aviation and vehicle building branches. In December 1934 NKTP ordered that in future the auto-tractor factories would be supplied by the domestic industry, further intensifying pressure on the machine tool branch. These new demands came at a time when the production base of the specialised industry was much the same as it had been during the First Five-year Plan; the only differences were that the Leningrad im. Il'icha works had entered the Glavk and the Khar'kov factory was entering service.

The problems of widening the tipazh of high-productivity machines were discussed at the Third Conference of Designers in March 1935, which marked a much more decisive turn towards the building of specialised machine tools.² Sorokin wrote that the first 'organisational phase' of the industry's development was now over³. It was decided that the leading enterprises would switch to building predominantly high-productivity types, in particular automatics and semi-autos; that a policy of building 'basic' models would be adopted - each such model would serve as the basis for a unified series of variants (or gamma); and that the building of unit-construction machines would be developed intensively.⁴ These latter measures followed earlier proposals of both Sorokin and Al'perovich and can be

1. Izvestiya, 27.5.1934.

2. See Chapter 7.

3. ZaInd., 20.3.1935.

4. Sotsialisticheskaya rekonstruktsiya i nauka, 1935, No. 6, pp. 158-159; ZaInd., 24.3.1935.

seen as attempts to enhance the seriality of production in the face of a general tendency towards despecialisation.

During the First Five-year Plan period , as we have shown, the structure and methods of the machine tool industry of capitalist countries had been regarded by all Soviet observers as irrational. The multitude of small firms producing a highly diversified product range with reliance on small serial and individual production based on highly skilled labour had been regarded as a product of the inherent anarchy of capitalist production. For the Soviet industry, in the condition of the socialist planned economy, the path indicated by the German rationalisation movement had seemed more rational ,i.e. the organisation of large-serial production of a limited product range , allowing the employment of less skilled workers by applying many jigs and fixtures. Until 1935 there is no evidence that this Soviet assessment of capitalist machine tool building had altered; in fact Al'perovich had continued to stress that the Soviet industry had been unable to follow the Western 'model'. But in 1935 in the wake of the conference of designers there was some reassessment of the hitherto accepted view, notably on the question of the scale of machine tool building factories. One of the most significant contributions at this time was that of E. Levin, director of ENIMS, in July 1935.

The first priority of the Soviet industry was now the building of more complex high-productivity machines , Levin wrote, but the basic line of development remained the rational reduction of the number of types and sizes built, thereby raising the seriality of production and lowering costs. The vast number of types and sizes which would nevertheless be required meant that even though the demand for machine tools presented by Soviet industry was considerable, production could not be organised on a mass basis. Levin continued:

"The production apparatus of machine tool building must be to the highest degree flexible, not only in order to continuously improve the design of produced machine tools, but also to rapidly and boldly switch to completely new designs, which is particularly difficult and complex for large-scale enterprises. Therefore, it is no accident that both American and European machine tool building factories are small enterprises with 300-500 workers

but with very large and highly-developed design offices. Even the largest world machine tool building firms such as, for example, Cincinnati, Herbert, and Ludwig Loewe, building an extremely diverse tipazh of metal cutting machine tools, are in essence combines of specialised factories. This also explains the growth in the number of machine tool factories".¹

These facts demonstrated, Levin concluded, that "...the production of an enormous tipazh of machine tools requires a significant decentralisation of production at many enterprises". This statement suggests that Levin believed the giant factories of the First Plan period to have been a mistake; this assumption is supported by his comments on the industry's experience:

"All the initial attempts to concentrate production of the required tipazh at 10-15 specialised machine tool building factories did not give positive results; on the contrary, in some cases it served as one of the causes of the slow assimilation of new types of machine tools, the inordinate complication of production organisation and, moreover, the increase in cost of the products built. Only after the number of enterprises involved in the production of machine tools was increased (at present there are about forty) did the up-turn in the development of the Soviet machine tool building industry begin - both in terms of the number of produced machines, and in relation to the number of assimilated types and sizes".²

Levin also went on to argue that the form of specialisation adopted in the Soviet industry was no longer appropriate. In Western Europe and America, he wrote, machine tool factories were predominantly specialised by type of machine. At first the Soviet industry had taken the same path; correctly in Levin's view because of the need to rapidly increase output. But the tasks of creating new designs and fostering technical progress required that enterprises be specialised according to the technology concerned. Thus, 'Komsomolets' would make all machine tools related to cylindrical gears; im.TsK.Mashinostroeniya all machines concerned with making and finishing threads; and im.Lenina all concerned with making and finishing holes. This revised form of specialisation was in fact adopted in subsequent years.

1. Planovoe khozyaistvo, 1935, N^o. 7, p. 20. Emphasis added.

2. ibid.

Levin's reassessment of the organisation of machine tool building in the capitalist countries hinged around a single factor - the demands of technical progress. It was this factor which had been left out of account in the discussion and policy conclusions of the First Five-year Plan years; or, if it had been considered, its full implications had not been perceived. This lacuna must be seen in the broader context of the prevailing perception of technical progress at the time of the capitalist crisis reviewed in Chapter 8. The new tasks posed before the industry, and the ⁵acknowledgement of the reality of continued technical development, together forced leaders of the industry to look more deeply at the logic of the industrial structure pertaining abroad.

Just before the convening of a major Party technical conference of the Glavk in July, Shaumyan reentered the debate, clearly judging the time right to once again put forward the arguments he had advanced at the 1933 conference. The new conference was devoted to a discussion of the practical problems of building the high quality high-productivity machines required by the auto-tractor industry, and this was the focus of the contribution by Shaumyan and a colleague, Agapov. They began by contrasting without comment the large, well-equipped Soviet machine tool factories with the typical small Western factory which often had obsolete machines. The Soviet industry built predominantly universal machine tools of low-productivity types. The few specialised models built (like the centreless grinder of the Tula factory and the semi-automatic lathes of the Im. Ordzhonikidze works) were of high-productivity types, but most such models were only being built in units in experimental shops. In the view of these specialists the root of the problem lay in a fundamental misapprehension of the very nature of modern machine tool building. There was, they pointed out, a basic contradiction between the development of mass-flow production in the engineering industry and the development of the machine tool industry: the more highly developed the former, the more high-productivity, specialised machine tools were required, and consequently the less the applicability of large-serial or mass methods in machine tool building itself. This was so first because the quantity of such machines required

was limited and, second, because the length of time required to organise their large-scale production inevitably exceeded the time of their 'moral' obsolescence. Machine tool building, they emphasised, had to constantly change the design of machines and also cheapen and accelerate their production. At the root of the problem, in their opinion, lay the question of the skills of those building the machines:

"The large-serial production of machine tools existing up to now at the machine tool building giants does not demand a large number of highly skilled workers and does not facilitate their training. Once organised this production proceeds mechanically; the worker makes use of complex fixtures which demand nothing of him but a certain skill and attention. It is a completely different situation when a factory produces small-serial special machine tools. Here reliance is placed firstly on the design office, and secondly on the highly skilled worker, who can almost without any fixtures, make complex and accurate parts by working to drawings and marking-up".¹

The example of the achievements of the experimental shop of the 'Krasnyi Proletarii' factory showed, Shaumyan and Agapov claimed, the correct way forward. Here in a short period of time a shop with only a hundred workers had succeeded in building six new types of machine tools. The circumstances of this production were such that workers quickly acquired skills through being given large tasks and responsibility. Therefore, they concluded, ". all the talk about the necessity of taking decades for training cadres is utter nonsense . A most rapid transition of the basic shops to the new tipazh and new methods of work will help to solve the problem of cadres, which was almost insoluble under the previous conditions".

In July 1933 Al'perovich had rejected this argument on the grounds that it was one sided: it ignored completely the question of building general-purpose machines and other types required in large quantity by Soviet industry. In restating his case Shaumyan again adopted this one sided stand, but now in 1935 his case must have seemed far more convincing given the new tasks facing the branch. But Shaumyan's approach failed to tackle two practical problems then facing the enterprises; first, that of making the transition from the building of prototypes

1. Izvestiya, 5.7.1935.

and individual special machines on a one-off basis to organising successful serial production, even if of a small scale, which, despite Shaumyan's arguments, was still required; second, that of producing in quantity commonly used types of machines of high technical level, such production representing the core of the output programme which all enterprises were under considerable pressure to fulfil. The enterprises, despite the new demands, were strongly disposed towards maintaining a high level of seriality of their production¹, and even to increasing the scale of production of at least one basic model in order to ensure that output in quantity terms rose from year to year while efforts were being devoted to the assimilation of new models. Adoption of the Shaumyan proposals would have inevitably entailed a rapid and pronounced drop in output. It is also doubtful whether the proposed approach would in practice have resulted in such a quick and automatic training of workers as Shaumyan envisaged.

The contradiction between the necessity of increasing the tipazh and of maintaining a high and rising level of output could clearly not be met by adopting Shaumyan's advice alone. Other paths had to be found in order to secure continued development of the industry. Starting in 1935, but more seriously during and after 1936, alternative means of resolving the contradiction were put forward and to some extent put into practice. The three main paths advocated were the development of standardisation of parts and assemblies, in particular the development of unit-construction; the development of specialised production of parts and assemblies and supply on a cooperation basis; and the development of flow production methods for the building of basic general-purpose machines.

The development of standardisation as a means of raising the seriality of production had been accepted as a policy aim from the early days of the industry, but despite the vigorous advocacy of the principle by the Central Institute of Labour (TsIT), the idea of building unit-construction machines was not seriously taken up by the specialised industry until 1935. Work on unit-construction was at this time restricted to 'Stankokonstruktsiya'; this did, however, free the main factories from having to build certain types of special equipment. The interesting, original work of TsIT on unit-construction is discussed in Appendix 7.

1. It was noted in 1935 that in order to raise the level of seriality the 'Krasnyi Proletarii' factory was building the MT-20 multi-tool lathe in the first half of the year and the larger MT-30 in the second, instead of making them in parallel. Vestnik metallorromyshlennosti. 1935. No. 10, pp. 12-13.

The promotion of production cooperation for the supply of parts and assemblies in 1936 and 1937 is discussed elsewhere. This policy was regarded as essential in order to accelerate the rate of introduction of new machines, free capacity at the basic factories, reduce the cost of the items concerned, and improve their quality by specialising the production technology. There is no doubt that the practice of the American machine tool industry was an important influence, but also to some extent that of the British industry, the level of sub-contracting of which had impressed Soviet visitors at the time of the 1934 London machine tool exhibition.¹

The third line of policy was put forward in the autumn of 1936. Several writers on the subject of introducing flow and conveyer technology into the industry made reference to Ordzhonikidze's demand in that year for conveyers to be introduced into the aircraft industry.² One of the first to propose the adoption of flow assembly with the use of conveyers in the machine tool industry was Stepanov, the deputy head of GUSIP, at a meeting of ENIMS and machine tool users in September 1936.³ The use of such production organisation presupposed a large volume of output of homogeneous products. Such a large volume could only be secured for commonly used types and 'basic' models of general-purpose machines. The industry was in fact beginning to see a reversion to some of the ideas of the First Five-year Plan years. The leading, very large enterprises of the branch, notably 'Krasnyi Proletarii', im. Ordzhonikidze, Gor'kii, and im. Lenina, were taking on a dual character. On the one hand, in accordance with the urgent demands of the time, they were becoming leading centres for the building of specialised, high-productivity machine tools required by the auto-tractor, aviation and other high priority branches; on the other, they were in effect carrying on the policy of Phase Two and building a comparatively narrow range of basic models of general-purpose machines on a medium and large serial basis using many jigs and fixtures. From 1936 the demand for the adoption of flow production techniques for this sector was raised; in 1937 there were demands for the adoption of other progressive technology of the auto-tractor industry, in particular automatics, semi-autos, multi-tool and multi-spindle machine tools, in order to raise productivity. This development was

1. ZaInd., 6.1.1935.

2. The 'conveyerisation' of aero-engine factories did in fact begin in 1937 - Mashinostroenie, 4.3.1940.

not incompatible with the policy for Phase Three as put forward by Al'perovich in July 1933, but was very far from the path advocated by Shaumyan.

The adoption of elements of the high-productivity technology of the auto-tractor industry for the production of machine tools built on a large-serial basis had the support of Al'perovich in one of his last articles in May 1937. At the same time he envisaged the organisation of the production of certain standard assemblies common to many types of machine tools at special factories on a large serial basis. The widescale development of standardisation, the unit-construction principle, and cooperation would be essential, he wrote, if the industry was to succeed in reaching the probable final year targets of the coming Third Five-year Plan, then seen as 70,000 units output and a product range of 1,000 types and sizes (compared with the 300 or so then in production). Such a growth of output would require an expansion of capacity, but Al'perovich stressed that it would not be necessary to build 'giant' factories. It is evident that he had some sympathy with Levin's reassessment of the optimal scale of machine tool factories because he now proposed the building of ten new enterprises of average size, with 700 - 1,000 workers each.¹ Al'perovich added that the development of specialised parts production foreseen during the Third Plan would give the possibility of building these new enterprises with less capital investment than would otherwise have been the case. While these new enterprises would be essential for covering the large planned tipazh, the existing large enterprises would have to be used to make part of the output of commonly used machines on a large-serial basis.

In considering the scale of new enterprises it should be noted that action had already been taken in the previous year to reduce the project capacity of two of the new enterprises of the Second Five-year Plan: the full capacity of the Kiev im.Gor'kogo automatics factory had been cut from 2,000 units, as seen in 1934 and early 1935, to 650 units in the autumn of 1935 and 500 units in 1936; the project capacity of the Saratov gear-cutting machine works had been similarly cut from 1,500 units to 750.² It is not clear, however, whether this measure was

1. ZaInd., 8.5.1937. For comparison, the im. Ordzhonikidze factory then had a total labour force of 3,770, including 2,850 production workers - ibid., 9.1.1937.

2. See Table SA.XXVII.

prompted by a reassessment of the desirable scale, or simply a response to an inadequacy of investment resources. Al'perovich's comments on the scale of future factories were made before the attack on 'gigantomania' which received official backing in February 1938 and wide publicity when Molotov condemned it at the Eighteenth Party Congress in 1939.¹ It is not surprising therefore that his proposal came under attack. One critic, R. Dorogov, accused Al'perovich of putting forward a 'farmers' solution to the problem of expanding production capacity. He believed that enterprises of 2,500-3,000 workers were most expedient because they were large enough to support a small experimental base and a design office able to undertake modifications and modernisation work. He also believed that only three or five new enterprises would be adequate for the branch.² However, the branch leadership did not alter its policy; an editorial of Stanki i Instrument on the Third Plan in July reiterated the view that at least ten small new factories were required for flexibility.³

The Third Five-year Plan itself endorsed the new approach on the question of scale. It called for the building of a number of new enterprises of average size for a number of types, including automatics, planing, boring, vertical turning and boring machines and grinding machines, to be located predominantly in the Urals, Siberia and Far East.⁴ Strategic considerations were clearly to the fore, and this was true to an even greater extent in the September 1939 SNK decree which called for the construction of a large number of new factories for almost all the basic types. But these projected factories were by no means small: two of the main projects of 1940 were the Alapaevsk automatics and turret lathes factory with a project capacity of 1,000 units a year and the Penza precision machine tool works of 3,000 units a year (of relatively small machines).⁵

During the Third Five-year Plan discussion of general questions relating to the strategy of development of the industry notably diminished, probably because by this time the question had in the main been resolved; the structure of the industry had been formed and had general acceptance. However, the shift in the direction of reestablishing the role of large-serial production as an integral

1. Molotov had cautioned against 'gigantomania' at the 17th Party Congress in 1934, but this had little impact at the time.

2. ZaInd., 12.5.1937; An optimal scale of 2,500-3,000 workers was also supported by two other specialists, Kulikov and Demkov, - ZaInd., 26.5.1937.

component of the industry's structure, which had been evident since 1936, now became more marked. From 1933 to 1935, with the launching of the policy of Phase Three, primary attention had naturally been devoted to organising the individual and small-serial production of specialised, high-productivity models previously not built. But even at this time the building of certain widely used general-purpose machines on a large-scale basis had continued. By 1936 the continuing large demand for basic general-purpose machines, coupled with the shortage of skilled workers which still afflicted the branch, promoted a revival of interest in the methods of Phase Two. It is notable that Schlesinger outlined his support for mass production of machine tools in the Soviet press in June 1936⁶; this would probably have been unacceptable three years earlier. One of the most forthright statements of the modified Phase Three policy was that of Berri in 1938, which was strongly reminiscent of some of the contributions of an earlier period.

Mass and stable large-serial production did not take place under the conditions of capitalism, Berri declared:

"The well known attempts of German machine tool builders to switch to large-serial production of standard machine tools were not crowned with success. The crisis of 1929 struck the hardest those specialised factories and shops which had switched to large-serial production. The failures in the realm of organising large-serial and mass production of machine tools, inevitable in the conditions of capitalism, are converted by bourgeois technicians into a firm law, which they justify in terms of the specific features of machine tool building. The growth of the tipazh...undoubtedly makes the organisation of large-serial and mass production of machine tools more difficult. This complication acquires particular force in the conditions of capitalism, where the growth of the tipazh is spurred on vigorously by the intensive competition, patent considerations, etc.. In the conditions of the socialist economy there is both the possibility and the necessity of organising the flow production of machine tools of wide application. The thousands of repair shops of different branches of industry and our socialist agriculture, the mechanisation of which has achieved vast dimensions, need

3. SI, 1937, No. 13, p. 2.

4. Tretii pyatiletnii plan razvitiya narodnogo khozyaistva Soyuza SSR, op cit, p. 122.

5. Mashinostroenie, 8.3.1940.

6. See above, p. 111.

standard, simple machine tools of a modern type. This enormous demand is satisfied by us to an insignificant degree.... Our largest machine tool building factories ('Krasnyi Proletarii', im.Ordzhonikidze, Gor'kii) must already from 1939 develop the mass production of certain commonly used types of machine tools in parallel with the building of special machines of individual and small-serial production. Mass and large-serial production of commonly used machine tools must be organised at a high technical level. The standard machines need to be modernised every year".¹

Berri also called for the introduction of elements of mass and large-serial production into the building of more specialised machines by the further development of the standardisation of parts and assemblies. But while promoting the mass production of basic general-purpose machines, Berri clearly supported the line taken by Levin and Al'perovich earlier on the question of the scale of enterprises required for building such types as automatics, broaching machines, some types of grinding machines, unit-construction machines, etc. Citing American practice of building such types in enterprises of 500 to 1,000 workers, he called for this experience to be taken into account by the Soviet industry. Thus, the Soviet specialised machine tool industry was to have a structure consisting of a core of very large enterprises undertaking large-serial or even mass production of standard, basic, general-purpose machines of a high technical level, using methods drawing on elements of the practice of the auto-tractor industry, alongside the building of special and specialised machines required by the advanced technology high priority branches; and also a number of smaller factories specialised for the production of somewhat lower-volume, progressive types such as automatics, gear-cutting machines, grinding machines of different kinds - internal, surface, cylindrical, radial drilling machines, and broaching machines.

b) Practice

Even before the adoption of the policy of Phase Three the introduction of a number of new, modern designs during 1932 had led to some despecialisation of enterprises compared with 1931. From 1933 this process gathered pace. The number of types and sizes built by each enterprise of GUSIP rose rapidly, from an average

1. Planovoe khozyaistvo, 1938, no.9, p.45.

of 4.2 in 1933, to 6.4 in 1934, 8.3 in 1937 and 9.7 in 1940.¹ Such a rapid growth of the tipazh inevitably led to a lowering of the average output per type-size given the limitations of the production base. The average number of units built per type-size fell from 206 in 1933 to 119 in 1934, 105 in 1937 and 87 in 1940, although there was a slight up-turn in 1938 to 113.² However, this impression of despecialisation provided by the average units per type-size indicator requires qualification. If one considers the number of different types of machine tools built by each enterprise - an important determinant of the attainable level of seriality of production - and the number of distinct models, rather than sizes, the picture is rather different. Information on the specialisation of GUSIP factories in 1933, 1935 and 1940 is presented in the table on the following page. Owing to the nature of the sources used the data on types are more accurate than those on models, and in general the information is less reliable than that presented earlier for 1928/29-1933. Nevertheless, it can be seen that the level of specialisation of enterprises in terms of basic types built actually rose steadily in the period, reaching the 1931 level again by 1935, and a rather higher level for the industry as a whole in 1940. As the production base expanded types were transferred from the main enterprises to other factories. Furthermore, the total range of types built by the specialised industry expanded by half, from 16 to 24. At the same time the number of models built rose sharply, from 34 in 1933 to 150 in 1940, with a corresponding rise in the number of models per factory from 3.8 to 6.8. This process was particularly marked at the large new enterprises built during the First Five-year Plan period. However, the despecialisation was less than indicated at some of the leading factories of the branch because there was some unification of parts and assemblies between different models, permitting a higher level of seriality of production.³ It should be stressed that this table excludes 'Stankokonstruktsiya' and also special machines built in large number by the end of the period at the leading enterprises of the branch.

A further fact which must be taken into account in considering the impact of

1. See p.155.

2. See p.155.

3. For examples at a number of enterprises, including Gor'kii, Khar'kov, im. Ordzhonikidze and 'Krasnyi Proletarii' see SiI, 1935, No. 3, p. 36; Planovoe khozyaistvo, 1935, No. 7, p. 26; Gor'kovskii krai, 1935, No. 11-12, p. 63.

Table 4.II

The Specialisation of GUSIP Machine Tool Factories, 1933 - 1940

Enterprise	1933 T/M (Types)	1935 T/M (Types)	1940 T/M (Types)
'Krasnyi Proletarii'	2/6 (L,GC)	2/9 (L,GC)	2/10 (L,A)
im.Sverdlova	4/5 (P,B,Th,L)	3/6 (P,B,Th)	2/7 (P,B)
im.Lenina	3/7 (D,Th,L)	2/6 (D,Th)	4/9 (D,Th,B,H)
'Samotochka'(MSZ)	2/3 (Sh/Sl)	2/4 (Sh/Sl)	1/6 (Gs)
im.Tsk Mashinostroeniya	3/4 (L,TM,DS)	3/3 (L,TM,DS)	2/5 (L,TM)
'Komsomolets'	3/3 (L,GC,C)	3/4 (L,GC,C)	1/12 (GC)
Six old enterprises	17/28 (11 types)	15/32 (11 types)	12/49 (10 types)
Av. per enterprise	2.8/4.7	2.5/5.3	2.0/8.2
im.Grdzhonikidze	2/2 (T,A)	2/5 (T,A)	2/9 (T,A)
Gor'kii milling m.f.	1/2 (M)	1/9 (M)	2/26 (M,TM)
Khar'kov im.Molotova	2/2 (RD/Gc)	2/3 (RD,GC)	2/15 (RD,GC)
Nine basic enterprises	22/34 (16 types)	20/49 (16 types)	18/99 (14 types)
Av. per enterprise	2.4/3.8	2.2/5.4	2.0/11.0
im.II'icha	-	1/4 (Gtc)	1/5 (Gtc)
Saratov g-c m.f.	-	1/3 (GC)	1/2 (GC)
im.Sedina	-	n.a.	2/2 (VTB/D)
Sverdlovsk u-c m.f.	-	n.a.	1/2 (Pn)
im.Kirova (Tbilisi)	-	-	1/6 (Th)
'Stankonormal''	-	-	2/3 (Gs/Gcl)
Kiev im.Gor'kogo	-	-	1/4 (A)
'Kommunar'	-	-	2/3 (L,T)
Leningrad turret & a.	-	-	3/3 (L,T,A)
im.Voroshilova(Minsk)	-	-	2/4 (D,P)
im.Kirova (Minsk)	-	-	4/8 (Br,Th,DS,Cg)
im.Kirova (Vitebsk)	-	-	2/4 (D,Gtc)
im.Kirova (Gomel')	-	-	2/5 (Sh,Sl)
Total GUSIP factories	22/34 (16 types)	22/54 (17 types)	42/150 (24 types)
Av. per enterprise	2.4/3.8	2.0/4.9	1.9/6.8
Av.Seriality(units/M)	231	187	167*

- not in GUSIP.

* on basis of 1939 output Source: next page.

Key: T - number of types built.

M - number of models built - N.B. Approximate.

Types - L-lathes; T-turret lathes; A-automatics & semiautos; D -drilling mcs.;
 M-milling mcs.;B-Boring mcs.;P-planing mcs.;Sh-shaping mcs.;Sl-slotting;
 GC-gear-cutting mcs.;Th-threading mcs.;Gc-cylindrical grinding mcs.;
 Gs-surface grinding mcs.;Gi-internal grinding mcs.;Gcl-centreless grinding
 mcs.;Gtc-tool and cutter grinding mcs.;Br-broaching mcs.;DS-disc saws;
 TM-thread-milling mcs.;C-combined mcs.;Cg-centreing mcs.;Pn-precision mcs.
 H-honing mcs.;VTB-vertical turning and boring mcs.;RD-radial drilling mcs.

Source:

1933 - compiled from Table SA.XIII.

1935 - based on Metallorezhushchie stanki proizvodstva zavodov SSSR, M.-L., 1935.
(catalogue).

1940 - based on Metallorezhushchie stanki, Preiskurant, 1940-41gg., M.-L., 1941.

Seriality calculated from total branch output, Table SA.I.

Note, 1939 output taken because 1940 output probably includes production of a number of factories which entered the specialised industry at the end of the year and excluded from this table because information on their products is inadequate.

the policy of Phase Three is the extent to which factories continued to produce some basic models on a large-serial basis. In the case of almost all the leading factories at least one model or range was built in large quantity, providing the basic element of production in unit terms.¹ Other models were built on a much smaller scale basis, sometimes in separate machining-assembly shops or in experimental shops. Unfortunately the kind of detailed information on the output of individual models available for the First Five-year Plan is not obtainable for later years. However, some indication of the structure of output of a leading factory is provided by the following data relating to the im.Ordzhonikidze works: Table 4.III

The Structure of Output at the im.Ordzhonikidze Factory, 1934 and 1935
(units)

Model	1934				1935			
	Plan	%	Actual	%	Plan	%	Actual	
'136' turret lathe	600	65	462	76	775	75	n.a.	
'137' turret lathe	120	13	72	12	120	12		
'114' semi-automatic	120	13	74	12	60	6		
'116' semi-automatic	20	2			20	1		
'113' semi-automatic	60	7						
'123' automatic					12	1		
'1V38' turret					50	5		
All models	920	100	608	100	1037	100	1301	

Source: 1934P. - ZaInd., 15.3.34; A. - Vestnik metallopromyshlennosti, 1935, No.9, p.116.
1935P. - ZaInd., 9.5.35; A. - ZaInd., 8.1.36.

Thus in this case the '136' basic model accounted for about three-quarters of total output and was built on a scale sufficient to justify the use of special tooling. Scattered evidence for other leading factories confirms this pattern.

1. This probably accounts for the fact that at some of the largest leading factories the output per type-size rose steadily from 1934 to 1937, despite a marked rise in the tipazh, e.g. for Gor'kii and im.Ordzhonikidze - see Table SA.XXX.

Thus the im.Tsk Mashinostroeniya factory built 734 '162-SP' lathes in the first ten months of 1936 out of a total output in that period of 785 units (i.e. 94 per cent) while during the first half of 1935 the 'Krasnyi Proletarii' factory built 405 TN-20 lathes, and the im.Lenina factory made almost 550 '507' threading machines: both these models were relatively simple, and old, dating from 1929-30.¹ Large-serial production of basic models was not restricted to GUSIP enterprises; the Tula factory planned to build 700 of its 'Dzerzhinets' milling machine in 1936.²

The most striking case of the organisation of large-serial production, strongly reminiscent of the practice of Phase Two was at the 'Krasnyi Proletarii' factory. In 1936 it was planned to build the Type 26, the intended replacement of the DIP lathe, on a scale of 5,000 units a year, with a monthly output of 400 units as early as November 1937.³ If this had been achieved it would have been without precedent in machine tool building history up to that time. The building of this new machine was to involve very heavy use of fixtures and special tooling - 1,120 different fixtures and 1,200 different tools. According to the 1937 annual plan 1,100 units⁴ were to be built in the year, but in fact problems were encountered. The viability of the design was questioned and this model was not built on a large scale basis. However, this model is significant because it was the first to be assembled on a flow basis.

The idea of flow assembly of machine tools was not new: in 1933 specialists of the 'Krasnyi Proletarii' factory who had been abroad at foreign machine tool firms (presumably in Germany) drew up a project for organising the assembly of the tailstock of the DIP lathe on a flow basis, the process being broken up into separate, consecutive operations each fulfilled by a single specialised workers, the work travelling from worker to worker on a railed track. This method was also proposed for other important assemblies.⁵ This project was not introduced at the time, almost certainly because after the June 1933 Order and conference such large-serial organisation was not regarded as a first priority. Until about 1936 the development of machining technology seems to have had more attention than assembly on the grounds that the higher the level of this stage the easier the subsequent stage of assembly because parts would have a higher degree of interchange-

1. *Problemy ekonomiki*, 1935, No. 4, p. 201. ; *ZaInd.*, 12.11.36.

2. *ZaInd.*, 29.2.36.

3. *SI*, 1936, No. 8, p. 44.

4. *ZaInd.*, 22.9.36.

5. *Predpriyatie*, 1933, No. 12, p. 12.

ability. In fact this led to a neglect of assembly, which began to take an increasing share of the total production cycle and was characterised by low productivity methods with very little use of jigs and fixtures. As a result highly skilled fitters were required in order to obtain assembly of a reasonable quality.

In connection with the introduction of the Type 26, from about the second half of 1936, assembly work was reorganised, putting into practice the ideas of 1933 and the call for the adoption of the methods of the auto-tractor industry in machine tool building. The new methods also resembled those adopted at the machine tool factory of the Central Institute of Labour in 1933, when flow assembly of a simple lathe was successfully organised.¹ At first the assembly of major elements of the Type 26 was split up into many separate, consecutive operations, the elements (tailstocks, gearboxes, headstocks, tool rests, etc.) being conveyed from station to station by means of roller conveyers or on bogies running on rails. From May 1938 the general assembly of the whole machine was also organised on this basis, with the use of bogies and a railed track. At the same time many special and standard fixtures were introduced and minor mechanisation provided when appropriate. Later in 1939 assembly of the 'DIP 200' was also organised on this basis and plans were in hands for future flow assembly of the smaller serial 'DIP 300' and 'MT-31' models. Two main factors promoted this transition to flow assembly: first, and probably the most important, the differentiation of operations allowed the employment of less skilled labour; second, a substantial rise in labour productivity was possible - in practice an average increase of between thirty and forty per cent was claimed.² Elements of flow assembly were also introduced at other factories during the Third Five-year Plan, e.g. at Im. Ordzhonikidze³, while at the Gor'kii milling machine works flow-work was quite highly developed as early as 1937.⁴

During the years 1933 to the beginning of 1940 the number of factories of GUSIP increased from 9 to 23; of the additional 14 only four were specially built new machine tool factories, all of a relatively small scale compared with those built during the First Five-year Plan. Furthermore, the enterprises transferred to

1. See Appendix 7.

2. *Mashinostroitel'*, 1938, No. 10, p. 29-30; Ostrovskii, Z. I., *Ot Bromleya k 'Krasnomu Proletariyu'*, M., 1937, pp. 55-56.

3. *Mashinostroitel'*, 1940, No. 1, p. 19.

4. *ZaInd.*, 2.2.37.

the specialised industry from other branches tended to be smaller than the original six basic factories. Thus despite the continued growth of the main factories, the average size of GUSIP enterprises in terms of both number of workers and annual output in unit terms declined compared with Phase Two, although there was a limited up-turn in the years 1936 to 1938 when the number of enterprises in the branch temporarily stabilised.¹ In 1931 and 1932 three factories of the specialised industry built over one thousand unit in a year; in 1940, seven. Factories of the 'planned' industry tended to be smaller, especially towards the end of the period when the largest of them had all been absorbed into the specialised branch (with the exception of military producers). A very approximate estimate suggests an average annual output per 'planned' factory (including military) of 820 units in 1933 (cf. 870 for GUSIP), 530 in 1937 (877) and 370 in 1940 (840).² From the sparse information on the number of machine tool building military factories and their planned output in various years, it can be estimated that their average output in units was only slightly smaller than for GUSIP factories. Lack of data on the 'planned' factories makes it impossible to provide any meaningful comparisons with the level of concentration of machine tool industries of other countries.

In the initial period of Phase Three output in unit terms fell below the level of 1931 in the specialised branch, but from 1935 output recovered quite rapidly, reaching twice the 1933 level in 1937. By 1938 the output of 'Krasnyi Proletarii', despite a substantially increased tipazh, was two-thirds larger than in 1931, and in the first half of 1941 reached the very high rate of 450 units a month.³ The average value per unit machine rose very rapidly with the transition to new, modern designs + by almost five times between 1931 and 1937. Labour productivity in value terms rose rapidly with the transition to new models of higher unit value, but fell in terms of units built per workers to a low point in 1934, before rising to exceed the 1931 level again in 1938.⁴ Production costs were reduced by about 10 per cent a year between 1933 and 1936 as the new models introduced in 1932 and 1933 were assimilated. In general, it appears that GUSIP recovered from the short term negative consequences of the rapid expansion of the product range initiated

1. See below, p. 155.

in June 1933 by 1935. In 1936 the machine tool factories of GUSIP made an overall profit for the first time.

Some of the basic indicators of specialisation, scale, seriality and productivity for GUSIP enterprises are summarised in the following table and chart. These clearly reveal the main practical consequences of the policies of the three phases of the industry's development.

Table 4.IV

The Specialisation, Scale, Seriality of Production and Productivity of
Specialised Machine Tool Building Factories, 1928/29 - 1940

Year	Specialisation: per ent.			Scale: av. per ent.		Seriality:		Productivity
	No. of Types	No. of Models	No. of Types- sizes	Annual output (units)	No. of prodn. workers	Output per:		Output per prodn. wrkr. (units)
						T-S (units)	Model (units)	
	1	2	3	4	5	6	7	8
1928/29	3.5	4.0		427	695		106	0.61
1929/30	3.2	4.0		807	1,250		202	0.65
1931	2.2	3.0		1,280	1,700		498	0.75
1932	2.0	3.0	3.3	914	1,665	281	305	0.55
1933	2.4	3.8	4.2	871	1,470	206	231	0.59
1934			6.4	755	1,440	119		0.52
1935	2.0	4.9	6.4	721	1,320	112	187	0.55
1936			6.6	782	1,280	119		0.61
1937			8.3	877	1,360	105		0.64
1938			9.7	1,100	1,225	113		0.90
1939			10.0	1,088	1,075	109		1.00
1940	1.9	6.8	9.7	841	870	87	167	0.97

Source:

Cols. 1, 2 & 7 - from Tables 4.I and 4.II.

Col. 3.- calculated from Tables SA.XI and Table A.1.I.

Col. 4.- calculated from Tables SA.I and Table A.1.I.

Col. 5.- calculated from Tables 12.I, p.410 and Table A.1.I.

Col. 6.- calculated from Tables SA.I and Table SA.XI.

Col. 8.- from Table 13.VI, p.424.

2. Calculated from Tables SA.I and A.1.I.

3. Pravda, 7.10.1945.

4. See Table 13.VI., p.424.

Chart 4.I

The Specialisation of Enterprises

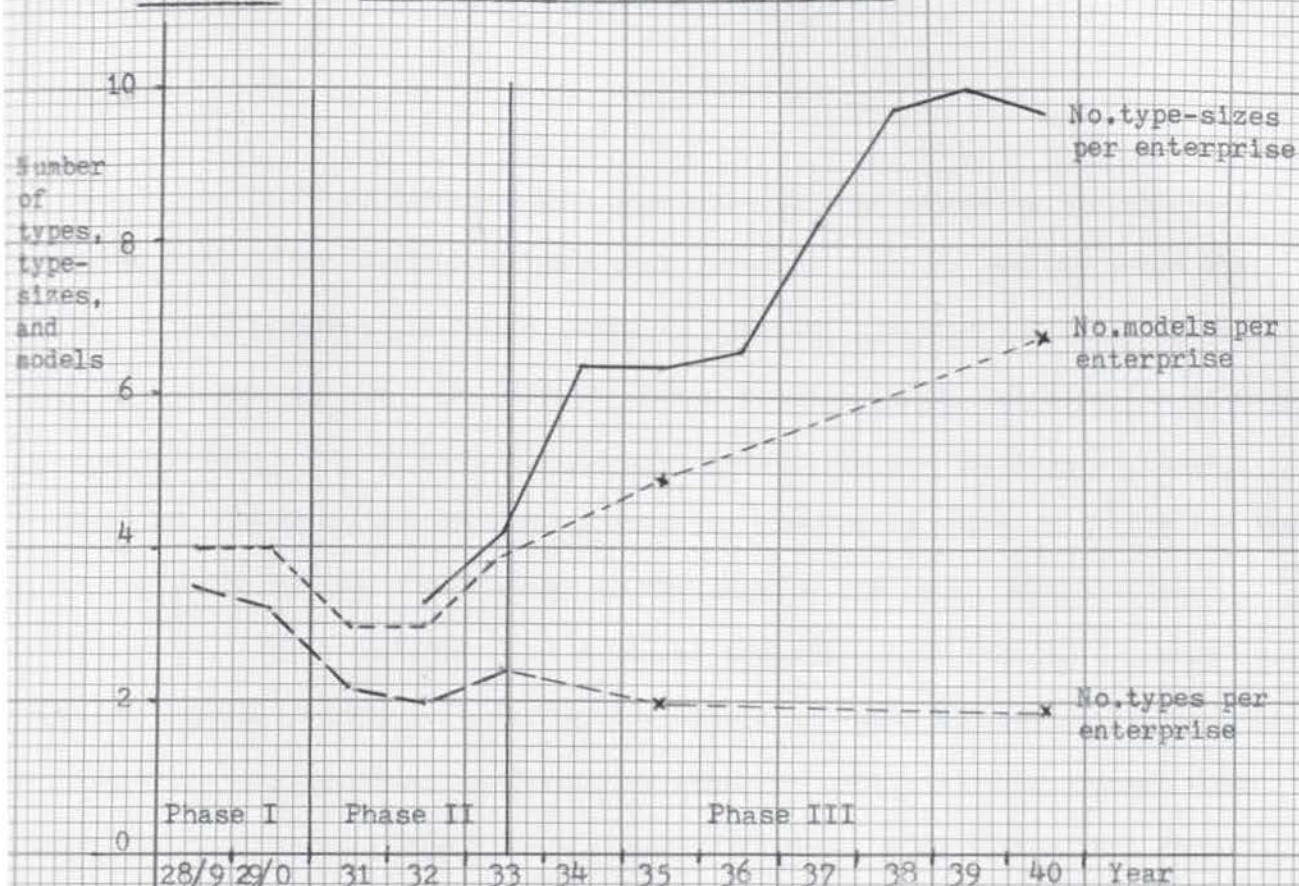
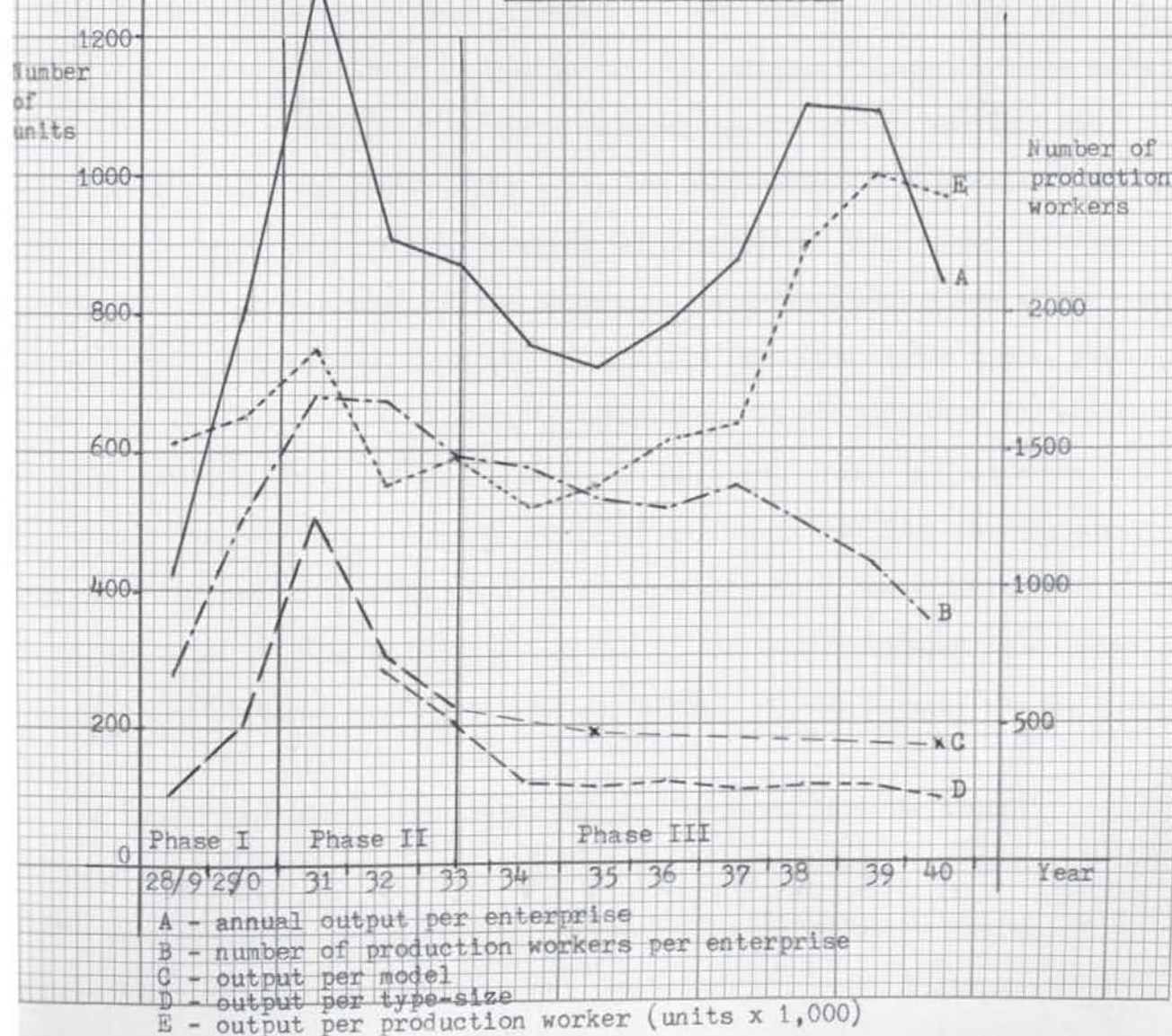


Chart 4.II

Scale of Enterprises, Seriality of Production and Labour Productivity



Conclusion

We are now in a position to draw some general conclusions on the strategy of development of the Soviet machine tool industry. In the pre-war years the industry went through a difficult learning process; learning not only the skills directly relating to the building of modern machine tools, but also the principles of organisation of the branch. The foreign influences are evident. At first the advanced practices of the German industry provided a guide to policy for the Soviet industry. In the first phase of development the basic organisational prerequisite - the existence of a separate administration for the industry - was lacking, placing definite limits on the extent to which the rationalisation policy could be put into practice. In Phase Two lines of policy already present were accentuated, possibly under direct German influence, giving rise to a very rapid growth of output at a time when the industry was beginning a transition to new modern designs, and when imports were at a very high level. At the same time, during this phase, many came to question whether foreign organisation and methods could provide any model for the Soviet industry operating, it was believed, under fundamentally different conditions. But this wholesale rejection of the practices of capitalist machine building was short-lived and did not have much influence on the development of the industry. With the introduction of new models and the policy turn in the direction of building more specialised types, practice began to be modified and this turn was accentuated in mid-1933 with the adoption of a new policy designed to secure a faster expansion of the product range. While many aspects of the previous stage continued essentially without change, now an 'American' style machine tool building was grafted on to the existing structure to produce a new synthesis, which by the end of the decade differed in a number of respects from ^{the} organisational structure and methods of both Germany and the United States.

The unique features of the Soviet industry stemmed from the specific conditions and demands of the Soviet economy and industry of the period. The relatively narrow product range, of both specialised and general-purpose machines, coupled with a large, rapidly growing, demand, permitted the organisation of large-serial

production of a limited range of basic models using methods relying heavily on fixtures and special tooling, with the employment of relatively low skilled labour. In this respect the Soviet industry took rationalisation further than in Germany, and this form of production of widely used models was to be retained as a characteristic feature of the Soviet machine tool industry in the post-war years. Whereas American machine tool building as a whole relied heavily on skilled labour and made only limited use of special tooling, in the Soviet case this approach was only adopted where essential for the building of specialised and special machines, the number of types and sizes of which was strictly controlled. In fact it was precisely the adoption of the methods of deskilling the production of the basic products, which permitted the transfer of the scarce skilled machine tool builders to the low seriality sector of the branch. Skilled toolmakers and engineers were of course necessary for devising the processes and making the tooling required for the large-serial production, but this must have been a more skill conserving path than that of basing the industry as a whole on highly skilled workers as was typical in other countries. Thus the Soviet strategy of development was designed to secure a rapid growth of output of modern machine tools, and a steady growth of the tipazh in order to minimise import dependence as quickly as possible, in circumstances of an acute shortage of skilled labour.

It is interesting to compare the Soviet strategy not with the practice of capitalist countries in 'normal' times, but during the exceptional conditions of wartime production. In these conditions it is necessary to build large quantities of standard machines employing workers of lower skills than usual. Examples are available from both American and British practice in these circumstances. During the First World War the British ministry of munitions took measures to reduce the product range of machine tools, the introduction of new designs was controlled, and factories were specialised by type of machine in order to raise the seriality of production and permit the employment of lower skilled labour.¹ During the Second World War a similar path was again followed by the British industry, and

1. Aldcroft, op cit, p.290.

flow production was raised as a practical policy for meeting the machine tool needs of military production.² But this experience was also typical of the American machine tool industry: flow production of machine tools was organised at a number of the largest factories, including Cincinnati, Browne and Sharpe, and Kearney and Trecker. This transition to large-serial flow production was facilitated by a reduction of the production range and the fact that there was a large, guaranteed market for general-purpose machines, not normally attainable in peace time conditions.³ In both the British and the American cases the normal operation of market forces was strictly circumscribed by direct state intervention to promote a rapid growth of output of machines of the required types. This example of Western practice throws light on the logic of the Soviet strategy, lending support to the view that it was a rational response to a particular set of economic circumstances.

But given this broad justification for the path adopted by the Soviet industry, its practical realisation was undoubtedly attended by a number of excesses and mistakes, in particular during Phase Two. This phase represented a transitional stage during which the industry began the switch to modern products and methods, while at the same time attempting to rapidly increase output in quantity terms in order to reduce imports. The development of large-serial production was a rational response to these demands, given the lack of skilled labour, but as was acknowledged from the summer of 1932, there was an insufficient appreciation of the economics of tooling-up this production. Provision of heavy tooling delayed the introduction of some of the new models and raised costs, while no allowance was made for the possibility of technical progress. These excesses stemmed not simply from the unbridled activity of productionmen in the circumstances of a sellers' market, but also from the general exaggerated view of the likely growth of output prevailing in 1931 and the first half of 1932. There is also no doubt that the labour skill requirements of the branch were underestimated at this time. These lessons were learnt during the difficult period of assimilating new models during the second half of 1932 and the first half of 1933, and this experience of the factories must have helped the Glavk leadership in its struggle to gain acceptance

of the need to modify policy.

The transition to Phase^{Three} did not represent an abandonment of the previous policy and practice, but its modification in order to secure a more rapid expansion of the product range and the building of more specialised models.⁴ This involved a shift of emphasis, but the large-serial production of general purpose machines continued and later, from the mid-'thirties again began to play a greater role. During the second half of the decade the 'production interests' criticised by Al'perovich in 1932 did to some extent reassert themselves, notably in relation to the 'Krasnyi Proletarii' factory's plans for replacing the 'DIP' lathe - the serious problems encountered by the enterprise in changing its basic model probably related in no small part to the very great envisaged scale of output. On the other hand the reassessment of the question of the optimal scale of factories marked a new stage in the learning process. It came to be appreciated that the scale of factories in the capitalist countries was not just the product of competition, but also a response to the demand for flexibility in order to secure

2. Thus, in 1940: "To this end (maximum output) the introduction of new designs has been reduced to a minimum, the production of special-purpose types is avoided as far as possible, and even standard ranges are being simplified by reducing the number of types and sizes offered. As a result it is possible to employ more intensive methods of production.." - *Machinery*, 15.8.1940, p.604, Editorial. On flow production, see *ibid.*, 28.11.1940, p.230, Editorial.

3. *Proizvodstvennyi apparat stankostroitel'noi promyshlennosti SShA*, M., 1970, p.85.

4. Granick has argued that while the specialisation policy of the First Five-year Plan period could possibly be justified in terms of the need to reduce import dependence at a time when the product range of the industry was very small, in fact this policy was 'abandoned' before its benefits in terms of reduced costs could be realised. Granick's interpretation of the specialisation policy of the machine tool industry during the pre-War years (*op.cit.*, pp.69-74) is open to a number of objections. First, and most important, Granick interprets the policy change of 1933 as marking a complete abandonment of the methods of Phase Two and a transition to a more traditional form of machine tool building founded on more highly skilled labour. But as we have shown, the large serial-production of general-purpose machines continued throughout the period and the advantages were realised. Second, he tends to exaggerate the extent of the despecialisation which took place after 1933, ignoring the fact that specialisation in terms of types of machine built by each enterprise actually rose, that the building of the low-seriality models tended to take place in separate shops or experimental shops, and that measures such as unification were adopted to raise seriality. Third, Granick thinks the investment in such large new works as the Gor'kii factory was misplaced, because it was undertaken at a time when the specialisation policy was at its height. This, he claims, had 'catastrophic' consequences at the Gor'kii factory when it had to adapt to a broader product range requiring more highly skilled labour. There were undoubtedly serious problems at this factory in the 1932-34 period, many stemming from the lack of skilled workers, but these were not directly related to the specialisation policy. It had been envisaged at the time of construction that this factory would build a large range of types and sizes of milling machines (as Al'perovich noted in 1931). The basic models which the works strived to assimilate

cont.next page..

regular technical progress, notably of the more specialised types. Soon after this the importance of specialised parts production for securing flexibility also came to be appreciated - this is considered in Chapter Six. However, these lessons were only partially put into practice and, in the case of scale, this was by accident as much as design in so far as few new factories were built and put into operation before 1941 and faute de mieux the existing enterprises transferred to the branch were fairly small compared with the 'giants' of the First Five-year plan.

This chapter has focused on the specialised machine tool industry with little attention to the so-called 'planned' enterprises of other branches of the engineering industry. At first sight the spread of machine tool building to these factories was at variance with the striving for specialisation and for the pursuit of a coherent strategy of development. If such machine tool building outside the Glavk had been uncontrolled and pursued by other glavki simply to meet their own needs and interests this would have been the case. But in fact the 'planned' factories only built types and sizes approved by GUSIP, and most of the main enterprises concerned were quite strictly specialised by type of machine. The extension of the 'planned' factory system during the 1930s facilitated the deepening of specialisation throughout the industry, because the widening of the production base allowed the transfer of type from the main enterprises of the branch to other factories suited to their production. The main sector of the 'planned' industry, the military machine tool building factories, was quite highly specialised and in general seems to have followed a similar path to that of the specialised industry.¹ Large serial production of basic models was undertaken in parallel with small-serial and individual production of specialised and special

in 1932 and 1933 remained in production on a large scale basis for a number of years - they were not affected by the change of policy. After the initial problems the factory quickly expanded production and its tipazh, becoming one of the most successful of the branch's enterprises by 1937. Granick argues that the case for what we have termed Phase Two was a weak one, but fails to demonstrate that an alternative approach founded on a more traditional reliance on skilled labour could have achieved the desired aims of rapidly expanding output and the tipazh, and raising the qualitative level of products and production methods.

1. The Izhevsk factory built lathes and turret lathes, with an unusually high degree of unification between the models; Tula focused on milling machines, but also made centreless grinding machines; im. Frunze, Penza, built automatics; the Lugansk factory specialised on grinding machines; im. Kalinina, Leningrad at first built turret lathes, later surface grinders, and two or three works specialised on the building of precision machine tools (catalogues and price lists of various years).

machines, the military factories enjoying an advantage in relation to the latter because they tended to have more highly skilled workers than was the case in the specialised industry during the early years. There was undoubtedly some erosion of specialisation, however, with the growth of machine tool building of a relatively low technical level at NKZem workshops, NKVD labour communes, local and cooperative industry, etc. in the course of the 'thirties. These producers supplied lower priority sectors of the economy and developed because the specialised industry was unable to satisfy demands for basic general-purpose machines.

The outstanding feature of the Soviet case was precisely that the machine tool industry was able to consciously evolve a strategy for its own development, whereas the industries of other countries grew in an anarchic manner over a period of many decades. This was possible because of the real, fundamental differences between the machine tool industry in the conditions of the Soviet, socialist planned economy, and under capitalism. Social ownership of the means of production provided the basic precondition for planning on the scale of the branch as a whole, giving the possibility of securing a unified, centralised technical-economic policy. It was this central control which permitted the enforcement of the factory specialisation policy and the limitation of the product range essential for rapid development in conditions of an acute shortage of skills.

Chapter 5

SPECIALIZATION BY PROCESS - THE CASE OF THE CENTRAL FOUNDRIES

Iron castings represent the primary material input of the machine tool industry and the availability of foundry facilities able to secure a regular supply of high quality castings is a basic condition for success in the branch. Steel castings, forgings and stampings are also required but in smaller quantities. The provision of foundry capacity was a major problem for the Soviet machine tool industry in the pre-War years and raised interesting policy questions. The policy and practice of the machine tool industry with regard to castings supply has received the critical attention of a Western economist, Granick, who provides a very negative assessment of Soviet experience in this area.¹ This chapter is devoted to a review of the evolution of policy and practice in the machine tool branch, focusing on the role of central foundries.

At the time of the creation of Stankotrest in October 1929 the situation with regard to foundry capacity at the enterprises then in the trust or shortly to join was as follows:

- 'Krasnyi Proletarii': no foundry, closed down in 1928²
- im.Sverdlova: own foundry, but capacity inadequate,³
- 'Dviagatel' Revolyutsii': own foundry, supplied other enterprises⁴
- 'Samotochka': own foundry, but old equipment and inadequate capacity⁵
- im.TsK Mashinostroeniya: own foundry, supplied other factories⁶
- im.Lenina: own foundry⁷
- 'Komsomolets': own foundry, small capacity⁸

In addition the main military producers, Tula and Izhevsk, both had their own foundry shops, presumably attached to the main production shops of the armament factories and having considerable experience. With the decision in the autumn

1. Granick, D., Soviet metal-fabricating and economic development, Wisconsin, 1967, pp.149-159.

2. Natsionalizatsiya promyshlennosti SSSR, M.-L., 1928, p.29.

3. Borisov and Vasil'ev, op cit, p.106.

4. Ek.Zhizn', 19.5.29; ZaInd., 9.9.33.

5. ZaInd., 10.12.32.

6. Lebyachenko, op cit, p.27.

7. Stennoqramy pervogo vsesoyuznogo soveshchaniya..., op cit, p.148.

8. Lebyachenko, op cit, p.29.

of 1929 to construct three new factories the trust was faced with a major policy issue: should the new and reconstructed enterprises all be provided with adequate foundries, or should capacity be centralised, existing capacity closed down, and castings supplied on a cooperation basis.

Two main factors appear to have influenced the trust's policy conclusion: first, the general policy discussion on the question of specialisation and cooperation of production in the engineering industry; second, the Soviet perception of the progressive foreign practice in the machine tool industry. The general policy debate on process specialisation started before the start of the First Five-year Plan, and by the time the Plan was approved in the spring of 1929 there was widespread agreement on the path to be adopted.¹ As early as April 1928 Gosplan approved a policy, incorporated in its directives for drawing up the Five-year Plan, of concentrating the production of homogeneous items according to their technological characteristics, so that the production of semi-fabricates would be separated off from the basic engineering enterprises and carried out at specialised factories.² In May 1928 the newspaper Torgovo-promyshlennaya gazeta opened its columns to a debate on 'what type of metal factories do new need?'. In his opening article, Lipovetski, a leading specialist of NK RKI, set the tone of the discussion. Sharply criticising what he regarded as a widespread bias towards the construction of 'closed', self-contained, integrated enterprises combining all stages of production under one roof, he argued forcefully for specialisation by process, with the creation of specialised preparatory shops located near raw material sources.³ This position was supported by all the participants and clearly enjoyed the support of the paper's editorial staff.

One of the contributors to this discussion was Al'perovich, head of Orgametall, who also wrote in favour of the development of cooperation between specialised enterprises producing a narrow range of products, with the separating off of complex technological processes, like casting and forging, into specialised activities. But he also sounded a note of caution - it would be a mistake to

1. This needs to be stressed because Granick focuses on the later discussion of
cont. next page.,

think that it would be possible to put these principles strictly into life at that time given the existing state of development of the economy. The striving for 'closed' enterprises apparent, he believed, in projects passing through the Scientific and Technical Council of VSNKh was, he stressed, an 'unhealthy deviation', but it stemmed from the fact that those responsible proceeded from the view that the difficult supply conditions then prevailing would continue into the future. There was thus a contradiction to be resolved in each particular case between correct principles and present objective conditions of supply, the difficulties of which were likely to be only slowly overcome in the course of the five year period. Al'perovich concluded his realistic contribution by stating his preference for specialisation whenever possible, and rejecting the path of building 'closed combines'.⁴

Other writers favouring specialisation included N.Vysochanskii⁵ (VSNKh-Glavmashinstroi), E.Lomov⁶, Pankin (who favoured a regional solution - independent foundry and forging factories serving a range of machining-assembly works of a given region)⁷ and Dobrovol'skii of Gipromez⁸, although the sincerity of the latter was questioned by other contributors, Nerverov and Fedorov, on the grounds that in practice Glavmetall and Gipromez had been favouring 'closed' enterprises.⁹ Thus by mid 1928 there was quite general support for the principle of specialised production of castings and forgings. Furthermore, in 1928 the first practical measures were taken: Mosmashtrest closed down a number of factory foundry shops, including that of 'Krasnyi Proletarii', and concentrated production at a central foundry at the im.Vladimir Il'icha factory.¹⁰ In November 1928, on the occasion of the meeting of machine tool building factory workers in Moscow, apparently for the first time, the question of building a castings factory for the machine tool industry was raised.¹¹ By December 1928 the

1931-32 as the primary influence on policy, ignoring the debate of the late twenties, which had much greater practical repercussions. This is related to a more fundamental weakness of his work - the neglect of the German influenced rationalisation movement of the 1920s, associated with NKRRKI, which leads to an overemphasis on American practice as the primary policy influence on the Soviet engineering industry of the First Five-year Plan.

2. Torg.-prom.gaz., 13.7.28, cited by Dobrovol'skii, deputy chairman of Gipromez.

3. ibid., 16.5.28.

6. ibid., 27.6.28.

9. ibid., 29.7.28; 3.8.28.

4. ibid., 12.6.28.

7. ibid., 30.6.28.

10. ibid., 29.8.28.

5. ibid., 15.6.28.

8. ibid., 13.7.28

concentration of semi-fabricates production at separate factories was Glavmashinstroi policy, incorporated in the VSNKh five-year plan for machine building, and this found its expression in the Five-year Plan as approved in May 1929, which provided for the construction of central foundries in Moscow (to serve Mosmashtrest) and Leningrad¹. Following VSNKh policy of the time, these were regional-type central foundries, serving a range of enterprises of the given area.²

By the end of 1929 Stankotrest had decided to build three new factories during the First Five-year Plan period, but it is not known whether policy for castings supply had been established at this stage. In early January 1930 Fedorov drew attention to the fact that there was already a castings 'famine' in the machine tool industry; at least 20,000 tonnes of castings a year would be required for the Moscow machine tool enterprises alone and, in his view, the only solution was the construction of an iron foundry factory specifically for these factories.³ By the end of January it was clear that the new enterprises were to be machining-assembly works, supplied with castings from outside.⁴ In the spring and summer of 1930 there appears to have been some uncertainty in the branch on the question of policy for castings supply and in May the issue was raised sharply in the press. While it was clear that the new enterprises were to be purely machining-assembly works, it was claimed that no practical measures had been taken for creating separate foundry capacity, with the result that there was a growing danger that the commissioning of the enterprises would be delayed.⁵ But it is evident that in the spring Stankotrest was attempting to clarify the possibility of obtaining a suitable project for building two central foundry factories for the branch: one in Moscow, and the other in Nizhni-Novgorod (Gor'kii) to serve the new milling machine factory. If a readymade project could not be obtained, the trust was intending to approach the Presidium of VSNKh for permission to have a project drawn up in the United States.⁶

11. Volkova, R.V., in *Istoriya KPSS - Marksizm-Leninizm v deistvie*, M., 1974, p.141.
 1. *Torg.-prom. gaz*, 28.12.28; *Pyatiletnii plan narodno-khozyaistvennogo stroitel'stva SSSR*, 3rd.edn., M., 1930, Supplement, pp10-11.
 2. VSNKh, *Osnovnye linii tekhnicheskoi rekonstruktsii promyshlennosti SSSR*, M., 1929, Vol.2, p.114.

By August 1930 the position had been clarified and Al'perovich, who up to this time had not referred to the question of castings supply in his published articles, outlined the industry's intentions. The existing foundry of the 'Dvigatel' Revolyutsii' factory in Nizhni-Novgorod was to be expanded (presumably to supply the milling machine works), the im.Sverdlova factory's foundry was to be rationalised, and for Moscow a new central foundry (tsentrolit) was to be built with an annual capacity of 30,000 tonnes a year.⁷ This decision was subsequently incorporated in the VSNKh order on the industry in mid-September⁸ and finally resolved by Stankoob"edinenie at the end of the month.⁹ The intention at this stage appears to have been to build a completely new factory, but this did not occur. Instead, apparently early in 1931, Stankoob"edinenie took over the central foundry already under construction for enterprises of the former Mosmashtrest, and located next to one of them, the 'Borets' factory.¹⁰

Three factors probably combined to bring about this solution. Firstly, the urgency of building a foundry for the new turret lathe factory which was to start work by the end of 1931; second, the acute pressure on resources which prevented the initiation of a new project (a pressure so acute that the Khar'kov construction had been put into conservation and even the turret lathe factory itself threatened); and thirdly, the fact that enterprises originally to have used the Mosmashtrest'centrolit' had by this time been subordinated to different ob"edineniya and new sources of castings supply found. At the end of 1930 this problem arose for the machine tool industry itself: the 'Dvigatel' Revolyutsii' factory was transferred to the diesel building administration, thereby depriving Stankoob"edinenie of control over what was to have been the foundry for the new milling machine factory.

At this stage it is useful to consider the second influence on Soviet policy

3. ZaInd., 3.1.30.

4. Izvestiya, 19.5.30.

5. ibid.

6. Byulleten' Stankotrest, 1930, No. 2-3, p. 70.

7. ZaInd., 5.8.30. There was no indication of policy for the Khar'kov factory.

8. Izvestiya, 20.9.30.

9. SiI, 1934, No. 10, p. 5.

10. ZaInd., 10.12.32.

namely the organisation of castings production in the machine tool industries of the leading capitalist countries or, more precisely, Soviet perception of this foreign experience. During the 1920s the most important and direct source of foreign experience was the German engineering industry with which the Soviet industry had well-established relations, notably through Orgametall and the Berlin technical bureau. For this reason it is of particular interest to examine German practice with regard to castings production. In examining foreign practice, and the Soviet perception of it, one must consider not simply the situation at any given point in time, but see the tendencies of development: Soviet industry was above all interested in the latest, most progressive practices of capitalist countries.

The practice of the German machine tool industry was analysed by Lazarev, writing in 1929: "For the present-day organisation of German machine tool factories the absence of foundries (frequently forges as well) is becoming all the more typical...as a result of which the machine tool factories are being transformed into purely mechanical enterprises (machining and the assembly of products)".¹ This process was also occurring in other branches of the German engineering industry, he observed, e.g. the majority of boiler making factories had liquidated their preparatory shops and were being supplied from specialised foundries. In support of his view that this was progressive practice, Lazarev noted that a Soviet engineer visiting Britain had found a similar pattern: of fifteen machine tool factories seen in Manchester, only four had had their own foundries.² Later, in mid-1930, Perel'man, of the Institute of Industrial-economic research of VSNKh, observed after a foreign study visit that in Germany the practice of obtaining ~~forgings~~ ^{castings} on a sub-contracting basis was especially well-developed in the engineering industry in general: of twenty two factories surveyed, only four or five had their own foundries. Perel'man also noted that "this already generally acknowledged principle" was not carried out with nearly the same directness in the USA: of 35 factories visited there, 25 had had their own foundries. No explanation was offered.³

1. Lazarev, V., *Ekonomicheskoe obozrenie*, 1929, No. 6, p. 47.

2. *Ibid.*, p. 48.

3. *ZaInd.*, 26.7.30.

The general strength of German influence in the late 1920s, coupled with the fact that the three new machine tool factories were projected in Berlin with German technical assistance, suggests very strongly that it was the German example that was being followed when they were conceived as machining-assembly enterprises supplied from separate specialised foundries. Later, after the adoption of this policy, examples of the practices of other countries were also cited in the Soviet press. In 1932 Oberin, after a very extensive tour of British machine tool factories, noted that thirteen out of a total of thirty enterprises visited had their own foundries, and even some of these purchased part of their requirements from outside suppliers. No explanation was offered for why firms adopted a particular pattern of supply, apart from tradition; no relationship between scale and the possession of a captive foundry was observed.¹ Furthermore, hardly any factories possessed their own forging capacity. In 1934 Piterov, head of Orgametall, after a trip to the USA wrote that of thirty machine tool factories visited, all but two or three received castings and forgings from outside suppliers, effectively making enterprises machining and assembly units. The quality of castings and forgings was, he stressed, very high.² Thus the practice of the three major machine tool producing countries appeared to indicate that the separation of preparatory activities from machine tool factories and their organisation on a specialised, centralised basis was a progressive policy worthy of emulation by the Soviet industry.

Stankoob"edinenie's enthusiasm for central foundries remained high throughout 1931. By the summer there was a firm intention to build a second one in Moscow and a site had been selected.³ In November/^{Al'perovich}restated the branch's policy: both new and old factories were to become machining-assembly enterprises. Looking back, he claimed that, "several years ago we fought with great persistence for the necessity of a special iron foundry base for machine tool building"; they had succeeded and now the central foundry would soon be in operation. However, the three Moscow machine tool factories alone would need 30,000 tonnes a year

1. *Vestnik metallopromyshlennosti*, 1932, No. 10, p. 57.

2. *ZaInd.*, 23.6.34.

3. *Ibid.*, 7.7.31.

at full capacity and this made it essential to build 'Tsentrolit' No.2 as quickly as possible.¹

In the autumn of 1931 a vigorous campaign developed for the creation of specialised, centralised preparatory capacity during the Second Five-year Plan. Earlier in the year there had been intermittent discussion of problems of specialisation, concentration and cooperation, notably in connection with initial plans for the development of the Urals-Kuznetsk Complex. In the course of this discussion some extreme positions were put forward as a number of economists and technical specialists called for the 'taking of specialisation to its limit'.² In October 1931 supporters of this tendency launched a campaign to make 1932 a 'year of specialisation and cooperation' with the intention of securing the fullest possible application of these principles in the Second Five-year Plan. From the start the building of central foundries and forges was a central element of policy and most participants, following previous practice, favoured regional semi-fabricates factories, rather than organisation on a branch basis. One participant, Reisler, specifically singled out Stankoob'edinenie for criticism for its intention to build two 'centrolits' in Moscow for its own use.³ All participants expressed concern over the continued practice of building 'closed' factories and the tendency of branches to avoid any relationship with enterprises of other branches. This 'departmentalism' and 'localism' was, they alleged, threatening the development of industry.

At the Seventeenth Party Conference in February 1932 Kuibyshev, outlining policy for the engineering industry in the Second Five-year Plan, called for the construction of 'narrowly specialised preparatory factories (casting, stamping, and forging)⁴. This edict must have given encouragement to those fighting for far-reaching process specialisation, and in the following three to four months reports began to appear of decisions taken by different regions on specialisation policy for the new Plan period, together with draft plans for the construction

1. *Za Ind.*, 7.11.31.

2. See the next chapter.

3. *Bol'shevik*, 1932, No. 1-2, p. 102.

4. Kuibyshev, V.V., *Iz bannye proizvedeniya*, M., 1958, p. 338.

of new central foundries and forges. Thus in March 1932 it was reported that Moscow intended to organise four regional 'centrolits' to be linked with metallurgical factories, and also a central forge; Leningrad was to build a number of regional 'centrolits' (ten to twelve in all) so that only seven or eight factories would retain their own foundry shops; Nizhni-Novgorod krai intended to organise a large-scale 'centrolit' for serving the engineering industry of the region.¹ At this time Stankoob"edinenie caused some annoyance to the upholders of regional 'centrolits' by its determination to adopt a branch solution. Early in 1932 the ob"edinenie put forward a new idea for solving the castings problem at two of the new enterprises, Gor'kii and Khar'kov: combines were to be built , incorporating two or more machine tool factories plus a foundry to serve the combine as a whole. The Gor'kii combine was to be based on the milling machine factory and was to include factories for the production of gear-cutting machines, grinding machines and lathes, while the Khar'kov combine was to have factories for making drilling and grinding machines. This approach was presumably adopted with a view to obtaining economies of scale in castings production.² These plans were to be shortlived.

In the second half of 1932 the Moscow 'centrolit', 'Stankolit' entered service and the two main new enterprises began to seriously assimilate production. At first the im. Ordzhonikidze and Gor'kii factories had to draw on a range of castings suppliers because 'Stankolit' was unable to meet their needs. Supplies were erratic and of poor quality , which greatly hindered assimilation of new models. Towards the end of 1932 and during 1933 there were frequent complaints in the press about the poor work of 'Stankolit' , notably from the Gor'kii factory which seems to have been particularly badly affected , partly because it was 450 km. away from Moscow , but also because it was forced to supplement its castings supply from a number of other sources, some of which were under other glavki. Difficulties were especially bad in relation to castings for new models - suppliers could not be bothered with small orders, but 'adopted an

1. Ek. Zhizn', 14.3.32.

2. Ibid.; SiI, 1932, No. 4, p. 21; Ek. Zhizn', 23.6.32.

anti-state commercial approach'.¹ These problems forced Al'perovich to acknowledge at the First All-Union Conference in July 1933 that the castings situation was far from satisfactory : "It is necessary to say directly as and this refers above all to myself, self-criticism, that we mechanics (mekhaniki) somewhat underestimated the complexity and difficulty of assimilating iron castings; and we are paying for it".²

In 1933 there was criticism of the poor work of 'Stankolit', but the policy of building the central foundry was not publicly criticised. The first public questioning of the policy of separating foundries from the machine tool enterprises was voiced in April 1934 by a leading engineer, Shifrin, who asked: "...is it not expedient for large machine tool factories to have their own foundries?".³ Shifrin directly related the need for such a reassessment with the change in the industry's general policy which had taken place since the First Five-year Plan. Formerly factories had been projected for the building of only two or three types each on a mass basis, now they were striving to rapidly widen the product range so that each factory would be building up to fifteen types and sizes, some on a small batch basis. In the new circumstances Shifrin considered that building foundries at each large factory was the only way to ensure high quality castings. The difficult situation at the Gor'kii factory provoked another observer, Tarlinskii, into an angry denunciation of the Glavk's whole policy with regard to castings supply: "... the construction of machine tool building factories without their own foundry shops, and equally the liquidation of foundry shops at old machine tool factories, was a most flagrant error".⁴ He agreed that in theory there were benefits to be derived from the centralisation of castings production - concentration of resources, ease of mechanisation, etc. - but in relation to the Gor'kii factory at least he believed that in practice results had been disastrous. Castings received from 'Stankolit' were extremely unsatisfactory and supply was made even worse by the situation on the railways.

1. Predpriyatie, No. 15-16, p. 20.

2. Stenogrammy, op cit, p. 26.

4. Predpriyatie, 1934, No. 19, p. 5.

3. ZaIhd., 2.4.34.

But a strong additional argument raised by Tarlinskii was that in the period of assimilation of new models it was essential for designers to participate in the making of castings; this was impossible for designers of the Gor'kii factory and the situation was exacerbated by the fact that all pattern making had also been centralised in Moscow. The result was that whole batches of castings received from 'Stankolit' had to be scrapped because of design errors. Finally, he also noted that at the time of its commissioning the works had had no forgings base and supplies had been obtained only through the personal contacts of the director with other enterprise directors. In order to secure supplies a small forge had been organised, meeting 40 per cent of requirements, but by October 1934 a proper mechanised forge was under construction.

Clearly if the original plans of the Glavk had been realised the construction of foundries at both Khar'kov and Gor'kii would have taken place during the Second Five-year Plan as part of the project for the creation of combines, but by late 1933 this scheme had been abandoned leaving the two large enterprises totally dependent on outside suppliers, frequently located at considerable distance. Gor'kii was supplied by 'Stankolit', im. Tsk Mashinostroeniya, 'Komsomolets', im. Sverdlova (Leningrad), the neighbouring 'Dvigatel' Revolyutsii' works and a number of other engineering factories.¹ Khar'kov was supplied primarily by the Odessa im. Lenina works, but also by about fifteen other engineering factories, some located as far afield as Ufa, Tashkent, and Ryazan.² In these circumstances it was hardly surprising that demands for the construction of on-site foundries began to be raised. Action was forthcoming, although the Glavk seems to have been very reluctant to alter its policy. In April 1934 there was a report that work was to start on a foundry shop at the Khar'kov factory; this was to be a powerful shop with a capacity of 18,000 tonnes a year. Construction work began before the end of the year.³ At the Gor'kii factory action was also taken after persistent demands by the factory for GUSIP to remedy the situation. It was at first decided that a small ~~factory~~^{foundry} of 1,500 tonnes capacity would be built in

1. *ibid.*

2. Khar'kovskii stankostroitel'nye, *op cit*, p. 34.

3. *ibid.*; *ZaInd.*, 23.4.34.

order to cover requirements for prototypes. At the same time Gipromash was exploring the possibility of building a second, larger foundry of 13,000 tonnes a year capacity, but this was not included in the 1935 Plan.¹

The building of foundries at Khar'kov and Gor'kii did not amount to a rejection by the Glavk of the policy of specialisation and centralisation of castings supply.² In 1935 GUSIP in fact took over the Leningrad 'Tsentrolit' and in the following year the Tbilisi 'Tsentrolit' also joined the Glavk, primarily as a castings base for the recently transferred im.Kirova factory. Furthermore, the new Kiev im.Gor'kogo automatic machine tool factory, construction of which began in 1934, was not originally provided with its own foundry: capacity was developed only later during the Third Five-year Plan, but by 1940 this amounted to only 2,000 tonnes a year.³ Thus, the policy of supplying castings on a cooperation basis was not rejected, but was to some extent modified. It is notable in this context that in 1935 and 1936 there were a number of reports that the work of 'Stankolit' was improving and certainly the volume of public criticism diminished. In fact after 1934 there was hardly a single criticism of the central foundry's work on the part of representatives of the 'Krasnyi Proletarii' and im.Ordzhonikidze factories, the two most fully dependent on its activities, apart from complaints about the excessive allowances (a general problem not specific to 'Stankolit') and the rough form in which castings were supplied.⁴

In an article at the end of 1936 the director of 'Stankolit', Fantalov, one of the most ardent supporters of the concept of 'centrolits', also supported modification of the original policy of meeting all requirements from centralised foundries. Fantalov criticised the Glavk for its policy of making 'Stankolit' produce castings for the tooling industry as well as for machine tools: the universalism of the foundry's product range was regarded as a major source of

1. *Predpriyatie*, 1934, No. 19, p. 5.

2. The ^{contrary} is implied by Granick on the basis of the above-cited Tarlinskii article: 'By late 1934 this policy of process specialisation had been recognised as a mistake' (pp. 81-82). But Tarlinskii was writing as an independent journalist and not as a spokesman of the Glavk which, from Tarlinskii's own account, strongly resisted the erosion of its policy.

3. *Mashinostroenie*, 8.3.40.

4. *ZaInd.*, 15.3.34; 9.1.36.

the factory's problems of quality and high cost. It was not the job of 'Stankolit' to produce all the castings required by GUSIP, he stressed. Some machine tool factories had their own small foundries, he noted, but instead of using them to meet their needs for small batch and individual castings they tried to satisfy their general castings needs, preventing 'Stankolit' from fulfilling its role as the main base for Moscow machine tool building. Thus Fantalov was arguing for situation in which factories would meet their own needs for one-off and small batch castings for prototypes and special models, leaving 'Stankolit' to concentrate on batch castings.¹

In 1937 and 1938 with the replacement of the industry's leadership past policies were subjected to critical review. But at this time hardly any criticisms was made of the policy of centralising castings supply; rather the Glavk's practical realisation of the policy was attacked and blamed for bringing the idea of 'centrolits' into disrepute. Thus Shestopal' and Berri asserted that, "The prevailing negative relationship to 'centrolits' because of the poor work of the Moscow 'Stankolit' factory, stems not from the unsoundness of the idea of 'centrolits', but exclusively from shortcomings of construction and leadership".² There were frequent accusations at this time that the construction of the 'centrolits' had been deliberately delayed: the action of 'wreckers' according to Berri in 1938.³

It is clear that foundry capacity at the enterprises was increased during the Second and Third Five-year Plan periods, but the construction of foundry shops at the new factories previously without them was slow. Investment resources were scattered over many projects and the building of foundry capacity appears to have had lower priority than the extension of basic machining-assembly shop capacity. The Khar'kov factory's foundry, started in 1934 had not been completed by 1940, although in operation at an earlier date.⁴ A foundry and forge were under construction in the Second Five-year Plan at the Gor'kii factory, but the foundry was not finished by 1940.⁵ At the end of 1939 the

1. *ZaInd.*, 10.12.36.

2. *Plan.Khoz.*, 1937, No. 7, p. 28.

3. *Ibid.*, 1938, No. 9, p. 39; see also *SiI*, 1937, No. 19, p. 2.

4. *Khar'kovskii stankostroitel'nye op cit*, pp. 31-34. In 1939 the factory was still being supplied by twelve factories. *Mashinostroenie*, 18.1.40.

'Stankokonstruktsiya' factory reported that it now able to make its own large castings and was free from dependence on 'Stankolit'.⁶ The new Saratov factory was building a foundry in 1940⁷, while the Krasnodar im. Medina factory had its own large foundry and supplied other machine tool factories in addition to providing castings for the Metro.⁸ Thus by the War almost all Soviet machine tool factories had their own foundry capacity, with the exception of 'Krasnyi Proletarii' and im. Ordzhonikidze and even in these cases it is possible that small foundries were built during the 'thirties to facilitate the building of prototypes, special and heavy machines. By the end of the 1930s the machine tool industry enterprises were obtaining over half their castings from specialised producers on a cooperation basis, a higher proportion than for any other branch of engineering,⁹ the average proportion for which was one sixth.¹⁰

Before assessing the machine tool industry's policy for castings supply the history the three central foundries will now be briefly reviewed, and the abortive project for a central foundry, 'tsentrokuz', considered.

'Stankolit'

The early history of this central foundry has already been discussed. Originally intended for Mosmashtrest, it was projected by Gipromash on the basis of materials supplied by Orgametail, suggesting possible German technical assistance.¹¹ It was transferred to the machine tool industry in 1931 and began operation in the following year, although at the time far from complete. From the start there were many serious problems stemming from lack of experience, the non-completed construction and poor leadership on the part of the Glavk. According to plans the full estimated value of the foundry should have been 28.6 million rubles, but by the beginning of 1933 only 12.3 million rubles worth of work had been carried out¹². For 1933 planned output was 13,500 tonnes; in fact output achieved only 7,500 tonnes.¹³ The official commissioning of 'Stankolit'

5. Mashinostroenie, 15.2.40.

6. *ibid.* 4.11.39.

7. *ibid.*, 8.3.40.

8. 50 let Krasnodarskii stankostroitel'nyi, Krasnodar, 1961, p.7; Plan. Khoz., 1938, No.7, p.51

9. Berri, L.Ya, Spetsializatsiya i kooperirovanie v promyshlennosti SSSR, M., 1954, p.252.

10. Volkov, S.A., Trudy Leningradskogo inzhenerno-ekonomicheskogo instituta im.

V.M. Molotova, Vyp.3, 1947, p.83.

(at the time called the factory im.Voroshilova, a name never used in practice) took place in March 1934 and it was then described as a fully mechanised works having superior equipment to the casting shops of the new tractor factories of Stalingrad and Khar'kov and the Gor'kii automobile works;¹ approximately seventy percent of machine tool castings were formed with the aid of machines.²

During the years 1933 and 1934 the poor work of 'Stankolit' earned it the reputation of being the worst factory in Moscow.³ One of the most serious problems was the low quality of castings produced. The spoilage rate in the first quarter of 1935 represented 36 per cent of gross output, but this was exceptional.⁴ For 1936 the annual average was 20 per cent rejects, 1937 17.7 per cent and 1938 17.0 per cent.⁵ These high rates must be seen in the light of the generally high rate of casting rejects at the time: in 1937 for machine building as a whole the rate was 17.8 per cent, and for the machine tool industry as a whole, 19.3 per cent.⁶ 'Stankolit's performance in this respect was in fact superior to that of some of the even larger foundry shops of the tractor factories, e.g. spoilage at the Chelyabinsk tractor factory was 23.0 per cent in 1936 and 24.6 in 1937.⁷ The poor quality of castings supplied to the factories caused considerable losses both through such faults as excessive hardness and above all because of the excessively large and variable allowances, which necessitated additional rough machining and complicated the use of fixtures and the maintenance of technological discipline.⁸ Furthermore, castings were supplied in unfettled form, forcing the factories to organise special fettling facilities.⁹ In 1935 and 1936 there appears to have been some improvement in 'Stankolit's performance, but this does not seem to have been maintained.

The performance of 'Stankolit' was evidently poor, but it is also clear

11.10 let Orgametall, op cit, p.65.

12. Proekt vtorogo pyatiletnego plana razvitiya narodnogo khozyaistva SSSR, M., 1934, Vol.1, supplement, Osnovnye ob'ekty kapital'nogo stroitel'stva, pp.48-49.

13. ZaInd., 10.12.32; 6.1.34.

1. SiI, 1934, No.6, p.38.

2. Volkov, op cit, p.91.

3. ZaInd., 28.10.35.

4.

5. Volkov, op cit, p.92. In 1940 the primary causes of spoilage were as follows: blisters 43.7 per cent of total; sand and slag inclusions 20.9 per cent; incorrect dimensions 17 per cent, and cracks 7.1 per cent (*ibid*).

6. Plan. Khoz., 1937, No.7, p.23.

7. Volkov, op cit, pp.112-113.

there were a number of substantial reasons for the situation, largely beyond the control of the factory itself. The two basic problems were, first, that the construction of the foundry was not completed as originally planned and, second, that the Glavk did not provide satisfactory conditions for its viable operation. The project capacity of the factory was 30,000 tonnes a year, to be reached by the end of 1936. In fact, capacity at the end of 1936 was only 18-20,000 tonnes.¹ But at this time the foundry was being expanded, not for the production of machine tool castings, but for casting tubing for the Metro.² The non-completion of construction meant that patterns had to be stored in the street or scattered around the shops, leading to damage and consequent waste of castings.³ On the second point, as noted above, the Glavk expected 'Stankolit' to produce castings for the tooling industry, despite the fact that the activity was very different from its basic task. This universalism of production was seen by supporters of the central foundry as a major reason for the high cost of castings.

In the Third Five-year Plan period the work of 'Stankolit' remained unsatisfactory: at the Second All-Union Conference of Foundrymen in December 1938 it was regarded as one of the three worst foundries in the country.⁴ Problems reported in 1940 were familiar: the programme of castings for small batch machine tools was not fulfilled, castings were not supplied in the necessary sets, delivery times were erratic, the proportion of scrap was high and allowances were excessive.⁵ By 1939 capacity had been increased to 55,000 tonnes and was still being expanded,⁶ but it appears that much of this extra capacity was not used for machine tool building.

'Tsentrolit'

The history of the Leningrad central foundry, 'Tsentrolit' has a number of similarities with that of 'Stankolit'. The construction of a central foundry to

8. *SI*, 1933, No. 10, p. 9.

9. *Plan. Khoz.*, 1938, No. 7, p. 51; *ZaInd.*, 9.1.36.

1. *ZaInd.*, 10.12.36.

2. *ZaInd.*, 28.5.36; *Narodnokhozyaistvennyi plan na 1936g.*, M., 1936, p. 328.

3. *Plan. Khoz.*, 1938, No. 6, p. 87.

4. *Volkov*, op. cit., p. 91.

5. *Plan. Khoz.*, 1940, No. 11-12, p. 146.

6. *Gosudarstvennyi plan razvitiya narodnogo khozyaistva soyuza SSR v 1939g.*, M.-L., 1939, p. 262.

serve engineering factories subordinated to Lenmashtrest was discussed by the Collegium of Glavmashinstroi as early as December 1928. It was then envisaged that this regional foundry would fully meet the needs of the Metallicheski factory im.Stalina, 'Russkii Dizel', 'Elektrosila' and the im.Sverdlova machine tool factory¹. The project, completed by March 1930, was elaborated first by Gipromez, later by Gipromash, and a capacity of 40,000 tonnes a year was envisaged.² With the dissolution of Lenmashtrest the central foundry was transferred to the 'Kotleturbina' trust.³ Construction began in August 1930.⁴ Early in 1932 it was envisaged that the 'centrolit' would supply castings to six Leningrad enterprises, including im.Sverdlova, with an output of 13,000 tonnes in 1933 rising to 60,000 tonnes in 1937.⁵ Considerable cost savings were predicted: 'Tsentrolit' was projected for an average per tonne cost of castings of 273 rubles, compared with a level of 559 rubles at the im.Sverdlova factory in December 1932.⁶

In December 1932 the question of for whom the foundry was being built was raised in the press. By this time it was in operation, but far from complete. Factories which were to have been supplied from it were opting out and beginning to build their own foundries so that 'Kotleturbina' was being forced to accept haphazard orders in order to use the capacity.⁷ According to the original project the foundry was to have consisted of two sections, one of small castings of up to 100kg., having a capacity of 12,250 tonnes, and one of large castings of up to 25 tonnes, with a capacity of 28,000 tonnes. The two shops were to share common auxiliary services and this was to be a major source of scale economies.⁸ In fact only the shop of large castings was built, and by the end of 1932 even this was only half completed and mechanisation of casting was almost non-existent.⁹

1. Torg.-prom.gaz., 6.12.28.

2. ibid.; Izvestiya, 6.7.30.

3. Izvestiya, 6.7.30.

4. Volkov, op cit, p.90.

5. 15 let bor'by za sovetskoe mashinostroenie, L.-M., 1932, p.261.

6. ZaInd., 3.12.32.

7. ibid.

8. Volkov, op cit, p.90.

9. ZaInd., 3.12.32.

The problem of demand and the non-completion of the foundry led to a slow rate of growth of output. In 1934 only 7,118 tonnes of castings were produced, rising to 10,913 tonnes in 1936¹, although the 1935 plan had provided for an output of 13,000 tonnes.² In 1935 'Tsentrolit' was transferred to GUSIP as a central foundry for the machine tool industry in general, and the im.Sverdlova factory in particular, but castings for other branches still formed a large part of total output.³ Factories supplied from the Leningrad factory in 1936 included 'Krasnyi Proletarii', the Khar'kov factory and the Zlatoust tooling works.⁴ Plans for the development of the foundry were reviewed and it was decided that the building of planing machines at the neighbouring im.Sverdlova factory would be transferred to a shop of heavy machine building at 'Tsentrolit'. Construction of this shop began in June 1937 and at the same time the two enterprises were combined. In the following year, however, construction of the new shop ceased and both enterprises regained their independence.⁵ In 1938 castings for machine tool building represented just over half total output of the foundry; other castings were made for turbine building and the Moscow Metro. In 1940 output reached 12,805 tonnes, 84 per cent representing machine tool castings.⁶ In 1941 the central foundry was renamed, 'Lenstankolit'.⁷

As with the Moscow foundry many of the problems of 'Tsentrolit' stemmed from the fact that its construction was not completed - before the War capacity was only half that originally planned. Overheads were extraordinarily high because equipment installed was designed for a considerably larger output than that achieved. Furthermore, many shops were not finished, including the repair shop, pattern and other stores, and a shop for rough machining and painting of castings. The non-completion of auxiliary shops meant that much production area was used instead, reducing capacity and productivity. Nevertheless, before the War the cost of castings supplied by 'Tsentrolit' was no higher than at other Leningrad foundries producing equivalent castings and labour productivity was higher than at foundry shops of such factories as 'Russkii Dizel' and im.Stalina, which should have been supplied by the central foundry according to the original plans.⁸

Tbilisi 'Tsentrolit'

In the late 1930s the machine tool glavk possessed a third central foundry in Tbilisi. Construction of this factory began in 1930 and by 1939 it had a capacity of 2,500 tonnes¹, although it was originally intended to have a capacity of 10,000 tonnes.² Prior to 1936 this foundry appears to have served a wide range of enterprises, in particular engineering factories associated with the oil industry.³ With the transfer to GUSIP of the im.Kirova factory from the oil engineering industry, the 'Tsentrolit' became a specialised machine tool industry foundry, supplying im.Kirova, which did not possess its own castings base.⁴

The Central Forge Project

The question of building 'tsentrokuzy', central forges on the lines of the central foundries, was raised on a number of occasions during the First Five-year Plan. Mezhlauk argued for powerful central forges as early as May 1928⁵, and in 1931 the newspaper Ekonomicheskaya Zhizn' promoted a vigorous campaign for their construction, with the participation of members of the Communist Academy and Gosplan⁶. In March 1932 it was reported that a central forge was to be built in Moscow to serve the region during the Second Five-year Plan.⁷ At some point early in the Second Plan GUSIP decided to build a central forge to serve the machine tool industry, locating it at the Murom 'Stankopatron' factory.⁸ In the autumn of 1934 it was reported that this forge was being equipped, and in August 1936 Lapin, chief engineer of the Glavk, reported that the central forge would be commissioned by the end of the year.⁹ However, in a detailed review of the state of cooperation in the branch in early 1937 Al'perovich made no mention of this project, and Berri, writing in 1938, observed that the forgings base had not been strengthened.¹⁰ The fact that this project was not mentioned again after 1936 must mean either that it was abandoned, or that the forge was completed but used for other purposes.

1. Finegenov, V.F., Leningradskii kommunisty v bor'be za tekhnicheskuyu rekonstruktsiya promyshlennosti, L., 1972, p.24.

2. Problemy ekonomiki, 1935, No.4, p.193.

3. Borisov and Vasil'ev, op cit, pp.182-183.

4. ZaInd., 3.2.37.

5. Borisov and Vasil'ev, op cit, p.182.

6. ibid., pp182-183.

An Assessment

Faced with a backward, universalist structure of industry inherited from Tsarist Russia, Soviet planners and technical specialists from about 1928 resolved to transform the engineering industry by adopting the progressive principles of process specialisation then highly developed in Germany and also practiced in the USA and to a lesser extent in Britain. In practice project organisations and planners favoured the building of regional central foundries and to a limited extent this idea was incorporated in the First Five-year Plan. The machine tool industry, following German practice, was in the forefront of this movement for process specialisation and projected its enterprises accordingly. The industry favoured branch 'centrolits', but in the event had to take over an existing project originally intended as a regional foundry, because time and investment resources were lacking. Envisaging rapid development of the industry the branch leadership intended to build further central foundries to serve other new enterprises or combines. With the sharp reduction in the planned rate of development of the industry which occurred in 1933 these plans had to be abandoned, leaving the Gor'kii and Khar'kov factories without local castings bases. The supply arrangements established for these enterprises were unsatisfactory and after pressure the glavk agreed to build foundry shops. Many problems were experienced with the central foundries; their construction dragged out and they suffered from poor leadership on the part of

7. Borisov and Vasil'ev, *op cit*, p.269. In the post-War years plans for uniting 'Lenstankolit' and im. Sverdlova were realised. The former began to build machine tools from 1955 and in 1959 the two enterprises were combined (*ibid.*, pp.271-274)

8. *ibid.*, p.182; Volkov, *op cit*, pp.92-93.

1. Gosudarstvennyi plan., 1939, *op cit*, p.262.

2. *Istoriya industrializatsii Gruzinskoi SSR, 1926-1941*, Tbilisi, 1968, p.365.

3. *ibid.*, p.509.

4. *ibid.*, pp.556, 822.

5. *Torg.-prom.gaz.*, 8.5.28.

6. *Ekonomicheskaya zhizn'*, 22.11.31; 15.11.31.

8. *Predpriyatie*, 1934, No.19, p.5.

7. *Ekonomicheskaya zhizn'*, 14.3.32.

9. *Plan.khoz.*, 1934, No.8-9, p.28; *Za'nd.*, 3.8.36.

10. *Za'nd.*, 9.1.37; *Plan.khoz.*, 1938, no.9, p.51.

the Glavk. These problems served to discredit the very idea of specialisation by process throughout the engineering industry. Nevertheless, the machine tool industry did not reject the principle: 'Stankolit' continued to be the main supplier of the Moscow machine tool factories and by the War half of all castings supplied in the branch were on a cooperation basis, a higher proportion than in any other branch.

There were a number of powerful arguments in favour of centralising castings production. The organisation of large-scale specialised foundries would permit the use of mechanised techniques and special equipment which were unprofitable in the small foundries attached to engineering factories. This had particular force in Soviet conditions of the late 'twenties when many factories of the industry had small, primitive foundries relying on hand work. Furthermore, central foundries would permit the concentration of skilled workers and specialists with a knowledge of casting technology, an important factor in the machine tool industry in view of its high quality requirements. The organisation of special foundry factories would also permit economies of scale in the provision of auxiliary services - pattern making, repairs, etc.¹ At the beginning of the First Five-year Plan these potential advantages of central foundries appear to have been seen in a rather abstract way, without account of the conditions which would make the theoretical benefits tangible. Insufficient account was taken of the degree of specialisation in terms of the homogeneity of castings required for the introduction of mechanised techniques securing worthwhile cost savings. The question of design stability and the need to allow for technical changes appears to have been overlooked, while the problems of building and assimilating large-scale new capacity were greatly underestimated. The former problem of securing homogeneity of castings was particularly acute for the regional foundry approach: the 'centrolits' as originally conceived were in fact highly universal enterprises serving a very broad range of users: in the case of the Leningrad 'Tsentrolit' its level of mechanisation would, as a result, have been lower than at some factory foundry shops. A final general difficulty was also underestimated - the problem of securing stable cooperation and supply

1. See Volkov, op cit, pp. 85-86 on the economic benefits of central foundries.

relations in the conditions of the Soviet economy of the period.

As Al'perovich admitted in 1933, the complexity of the problem of securing the machine tool industry a regular supply of good quality castings was seriously underestimated. The problems experienced were closely related to the general question of the strategy of development of the branch. At the time when the castings policy was adopted the branch was entering the second phase of its development with stress on the large-scale production of a limited range of products. Given these conditions the policy of building central foundries had a definite logic: the large-scale, relatively stable demand for castings would permit the use of mechanised techniques and offer the possibility of reaping economies of scale. If in 1929-30 the prospect of a much broader product range subject to regular technical change had been foreseen, and foreign experience examined a little more critically, rather different policy conclusions might have been reached.

The biggest problem experienced when machine tool factories were dependent on outside suppliers for castings was securing requirements for new models and one-off machines. The making of castings for prototypes required very close cooperation between designers, pattern makers and foundrymen; frequent changes of design and technology may be unavoidable before satisfactory permanent solutions are found. From 1933 when the product range began to expand rapidly and the building of specialised and special machines on an individual and small-batch basis began to be pursued as a regular activity alongside the medium and large batch production of general-purpose machines acute problems arose. The foundries were despecialised and the essential close contact with the factories was lacking, in particular for the Gor'kii factory located at a distance from Moscow. Thus, in deciding to take the path of process specialisation the industry seriously underestimated the implications of technical development and the broadening of the product range.

If foreign practice had been examined more closely it might have been seen that there was some relationship between the scale of foreign machine tool

factories and the pattern of supply. In Germany, where sub-contracting was highly developed, the majority of machine tool factories were small. In Britain there were a number of quite large factories, e.g. Herbert, Lang, Asquith, Archdale, etc., all smaller than those built in the USSR during the First Five-year Plan, but all possessing their own foundry capacity.¹ In the USA a similar tendency could have been observed. As the VSNKh report of 1929 on technical development during the First Five-year Plan itself noted, without comment, the Cincinnati milling machine factory, the largest in the USA, had built its own foundry as early as 1911 in order to secure a higher quality product than could be obtained on a sub-contract basis.² This trend was also noted by Wagoner in his history of the American machine tool industry: "There was a trend during the first decades of the twentieth century among the larger tool builders to acquire or establish their own foundries and thereby free themselves from the dependence of the not always very reliable services of the custom foundries".³ These larger firms in both countries produced a wide range of products and were in the vanguard of technical progress.

These considerations suggest that a more rational policy for the Glavk in the Second Five-year Plan would have been to adopt the solution put forward by Fantalov, the director of 'Stankolit' in 1936. The central foundries should have been completed and freed from all non-machine tool casting activity so that they could have concentrated on supplying castings for the medium and large batch models produced by all the major factories. At the same time foundry shops should have been built at all the leading enterprises of a sufficient scale to meet the demand for prototypes and individual and small batch production models. In the event the Glavk's indecisiveness caused unnecessary difficulties. On the one hand it failed to secure conditions for satisfactory work of the 'centrolits' (although to some extent this was beyond the Glavk's control, e.g. the production of Metro tubing and later, presumably, military items) and on the other it allowed enterprises to construct or reconstruct their own foundries on a scale sufficient to meet all or most of their requirements. This inevitably led to a scattering of investment resources, long construction delays and made it more difficult to

turn the 'centrolits' into viable enterprises. One has the impression that factory managers and possibly members of the Glavk administration were quite happy to see the 'centrolits' fail, and took no action in order to improve their work in order that the principle of 'own foundries' would be rehabilitated. They were not unsuccessful.

In the post war years a specialisation process on the lines of that indicated above appears to have been carried out and the performance of 'Stankolit' greatly improved. According to Berri the cost per tonne of castings produced by this foundry in 1953 was one half to a third of the level at foundry shops of the machine tool factories.⁴ In recent years new 'centrolits' have been built for the machine tool industry and process specialisation remains a basic element of policy.⁵

-
1. Oborin, V.F., Vestnik metallopromyshlennosti, 1932, No. 10, pp. 58-62. In his enthusiasm for the centralisation of castings production, Oborin denied that there was any relationship between scale and the possession of foundry capacity in the British machine tool industry. His own evidence demonstrates the contrary. Most of the largest British firms did have their own foundry shops, although in some cases part of requirements were met from outside; the only exceptions were Ward (wholly dependent on outside supplies) and Churchill, which obtained castings from another machine tool factory. Cincinnati,
 2. VSNKh, Osnovnye linii..., op cit, p. 114; see also Men of purpose, 1884-1964, ~~1964~~, 1965, p.
 3. Wagoner, op cit, p. 56. This tendency has continued since the war, the largest firms again being involved: in 1963 only 16 out of 800 machine tool firms had their own foundries, but they tended to be the very largest - Browne & Sharpe, Cincinnati, Gisholt, etc.. The proportion of castings produced from these captive foundries rose from 12 per cent of total castings produced for the industry in 1954 to 34 per cent in 1963 (Proizvodstvennyi apparat stankostroitel'noi promyshlennosti SShA, M., 1970, pp. 49-53)
 4. Berri, op cit, p. 199.
 5. We have found no evidence to support Granick's suggestion that the idea of centralisation and specialisation of castings production fell into official disfavour in the years 1940-54. Such works as Shestopal, V.M., Rok v proizvodve stanochnogo lit'ya, M., 1945; Omarovskii, op cit; Volkov, op cit. and Berri, 1954, all support the principle but, as opposed to the earlier period, are concerned to define more rigorously the conditions of its application, notably the work of Volkov who provides a detailed analysis of forms of organisation of castings production and the minimum and optimum scale of foundries. Berri is scathing about the ideas of the ultra-specialisers of 1931-32 and the building of universal regional foundries, but stresses that once properly specialised, the 'centrolits' were profitable enterprises (Berri, pp. 196-199). Later commentators on the pre-War central foundry experience were also agreed that the principle was correct, but that avoidable mistakes in its realisation served to discredit the idea. e.g., Omarovskii, A.G., Spetsializatsiya proizvodstva i razmeshchenie mashinostroitel'noi promyshlennosti SSSR, M., 1959, p. 44; Zabelin, B.M., Kontsentratsiya i spetsializatsiya promyshlennosti v usloviakh reformy, M., 1970, p. 21.

Some of the problems of castings supply were those common to all cooperation in the 1930s and will be considered in the following chapter. One difficulty experienced throughout the period was that castings were supplied with excessive allowances. This led to considerable wastage of metal and complicated the use of progressive technological processes: fixtures had to be designed with provision for a wide variation in the size of castings, and rough machining processes occupied a much larger role than usual in foreign engineering with a consequent high proportion of lathes in the machine tool stock. The major, but not sole, cause of this problem was the practice of assessing the performance of foundries by weight. At times there was an element of vested interest in this practice at the factory level, e.g. at the im. Ordzhonikidze factory in 1936 it was reported that workers received extra pay for machining off the excess metal.¹ There is no doubt that from the point of view of the foundries it was much easier to work to large allowances and for this reason the practice was widespread before the start of the First Five-year Plan.²

The machine tool industry experienced many problems with castings and forgings supply in the pre-War years. But this does not mean that the industry was wrong in attempting to introduce progressive principles of organisation at this time. The fact that the branch's leadership did not just accommodate itself to the traditions of the past and the transitional difficulties of the present is to its credit; to have done so would have been to abdicate its responsibility for raising the general technical and organisational level of the Soviet engineering industry. On the other hand the abstract approach of the ultra-specialisers of the years 1931 and 1932, who called for the taking of process specialisation to its limits and recommended the construction of regional central foundries and forges and the closing down of factory shops was clearly incorrect and if put into practice (which it was not) would have seriously disrupted Soviet industry in the 1930s.

1. *Mashinostroitel'*, 1936, No. 10, p. 19.

2. *Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami*, op cit, p. 162.

Chapter 6

SPECIALISATION BY PARTS IN THEORY AND PRACTICE

One form of division of labour in engineering production, namely process specialisation, has been considered; a second form, specialisation by parts, involving the organisation of specialised production of particular machine elements - parts, sub-assemblies, units, etc. as a separate activity was the object of lively debate during the First Five-year Plan period and had some limited practical application in subsequent years. As with process specialisation a precondition for the successful organisation of part specialisation is the existence of a sufficiently large demand for relatively homogeneous items, giving the possibility of scale economies from the use of specialised technology, the concentration of certain skills, the effective use of certain specialised auxiliary services, etc. The regular production of semi-fabricates or parts on a specialised basis gives rise to the possibility of establishing sub-contracting relations between a main factory producing a finished product and the specialised suppliers. In Soviet writings this relationship is subsumed under the concept of 'cooperation' (*kooperirovanie*), which can also have the meaning of the joint participation of two or more enterprises in the realisation of a specific project, or the use by one enterprise of spare capacity to produce items required by another enterprise on a more or less permanent basis. This latter form of cooperation may not involve specialisation of production: in fact this form of relationship may promote a universalisation of production at a given enterprise. This chapter is devoted to a review of the debate on parts specialisation and cooperation both in general and as applied to the machine tool industry, and also the practical development of the principle in the branch in the pre-war years.

The Debate of Specialisation by Parts

During the 1920s rationalisation of production was primarily directed towards securing conditions for raising the seriality of production at existing machine building enterprises, which were generally of a universal character. At this time

specialisation both in theory and practice tended to be restricted to branch specialisation and the specialisation of enterprises by type of product. From about 1928, as related above, process specialisation began to be discussed, but in the debate on the desirable type of enterprises for the engineering industry the question of parts specialisation was hardly raised at all, although one contributor, P. Fedorov, did argue that it was time to begin to think about factories making individual parts.¹

In 1929 and the first half of 1930 there was little public discussion of problems of specialisation by parts in the engineering industry, but a number of important practical cases arose which helped to set policy for the entire First Five-year Plan period. In 1929 a controversy broke out over the reconstruction of the AMO vehicle factory in Moscow - should it be a complex plant producing all main assemblies and components within its own walls, or should it be an assembly type factory supplied by specialised parts enterprises? The chief of the administration charged with the reconstruction, M. Sorokin, favoured the former, 'American', course; the director of the factory, Likhachev, the latter. This policy clash, which also involved questions of foreign technical assistance, was eventually resolved by the Politbureau at the end of January 1930 in Likhachev's favour. Stalin is reported to have taken the view that the first large factories had to be of the complex type because assimilation of production would be difficult and it would be easier to assist one factory than a dozen.² In the 1929-30 period it was also decided that the new tractor factories would be of the integrated type. These decisions by no means meant that these factories made everything for themselves: in all cases some major assemblies and parts were supplied from specialised producers.

A turning point in the discussion of the question of specialisation by parts came with the Prom. Party trial in late 1930. One of the charges against the

1. Torg.-prom.gaz., 3.8.28.

2. Direktor - I. A. Likhachev, M., 1971, pp. 14 and 251; Dobrovol'skii, E., Daesh avtomobil!, M., 1971, pp. 50-59.

defendants was that they deliberately held back the development of production socialisation in the engineering industry and the trial seems to have provided an opportunity for those favouring far-reaching specialisation to raise their voices. The first shots in the campaign were fired by Shukhgalt'er and Sorokin, the latter now head of Stankoimport. The former, in an article entitled, 'Decisively put an end to the consequences of wrecking in machine building', published while the trial was still in progress, called for a campaign under the banner of 'specialisation and cooperation in machine building'.¹ Taking advantage of this new situation, Sorokin restated the case he must have argued a year earlier and which had been rejected by the Politbureau. His article amounted to a wholesale rejection of the policy adopted by the auto-tractor industry of building integrated factories, which were dismissed by Sorokin as 'universal' enterprises and therefore by implication equated with the universal enterprises typical of Tsarist Russia. An outline of an alternative plan was presented, involving the construction of many narrowly-specialised parts producing factories serving assembly plants: this, Sorokin insisted, was a matter not of the Second Five-year Plan, but the First.²

This article by Sorokin was followed by further contributions on similar lines early in 1931 in which he further developed his arguments and extended them to the machine tool industry.³ Further fuel for the debate was applied by Gastev's work at the Central Institute of Labour: this was used by Perel'man and others for arguing that the very 'anatomy' of modern machines pointed to the necessity of building them from standard units produced by specialised factories. It would, Perel'man believed, be quite easy for socialist machine building to fully apply any good organisational principle which capitalism could not take to its logical conclusion.⁴

From the end of 1930 to about the summer of 1932 discussion of problems of specialisation in the engineering industry was dominated by a tendency, later rejected as a 'leftist' deviation (on the grounds that the ideas and proposals put forward were divorced from the demands and possibilities of objective reality), which called for the taking of specialisation 'to its limit'.⁵ This

'ultra-specialisation' tendency had representatives in Gosplan, the VSNKh Institute of industrial-economic research, the Communist Academy^{and} the press, notably the newspaper Ekonomicheskaya zhizn'.⁶ A major forum for discussion of problems of specialisation and cooperation in machine building was a discussion at the Communist Academy in the summer of 1931 at which two reports were presented; the first by Kritsman on specialisation and cooperation of parts producing factories, and the second by Perel'man on the application of these principles to the Ural-Kuznetsk Combine. Kritsman argued that the difficulties experienced at the Stalingrad tractor factory showed that the 'closed' enterprise even if of the mass-flow production type could not secure the mass production of all components, so that batch production with its inevitable switching of machines from one type of work to another had to be carried out alongside true mass production. Kritsman favoured the widescale development of specialised parts factories producing on a mass-flow basis, freeing the main factory solely for the assembly of the final product. This path, he claimed, would overcome the basic problem of the large enterprise - organisation. Acknowledging that strict standardisation of parts would be required, Kritsman argued that the building of specialised factories could not await such standardisation; rather the creation of the factories would create favourable conditions for carrying out the standardisation work. Admitting that this was an ambitious plan which could not be realised all at once, Kritsman nevertheless believed that there were no major obstacles to putting it into practice.⁷

1. Za ind. 7.12.30.

2. Ibid., 30.12.30.

3. See Bol'shevik, 1931, No. 6 for the fullest presentation of Sorokin's position.

4. VARNITSO, 1931, No. 3, pp. 20-21.

5. The first traced use of this term was by Veitsman, who after a visit to the USA and Germany with a commission of members of GOMZy and Mosgiprommez in early 1930 concluded that, while these organisations had already adopted the correct principles of concentration, specialisation and intensification of production, they had not been sufficiently decisive, and had 'not gone to the limit' (do kontsa) (Veitsman, S.E., Ob organizatsii proizvodstva na zavodakh metallopromyshlennosti Ameriki, M., 1930, p. 113.) This phrase was taken up by Perel'man (VARNITSO, 1931, No. 3, p. 22) and subsequently used by some participants in the Communist Academy debate.

6. The following were leading advocates of the 'ultra-specialisation' tendency: Kritsman, Dol'nikov, Guran, Sorokin, Perel'man, Rudakov and Kogan.

7. Spetsializatsiya i kooperirovanie v mashinostroenii SSSR, M.-L., 1931, pp. 7-18.

Kritsman's report to the Communist Academy meeting summarised the basic positions of the 'ultra-specialisation' tendency and was supported by all the other participants. The ideas of these specialists found their expression in initial plans for the Ural-Kuznetsk machine building combine, which was to include many specialised parts factories and a vehicle factory with an output of 2 million units a year!¹ This debate marked the apogee of the 'taking specialisation to its logical conclusion' tendency. In August 1930 Dol'nikov, one of the participants of the Communist Academy meeting, further elaborated his position according to which specialisation of parts production arose logically from the very anatomy of machines built under socialism. Specialised production organisation, in his view, had to be founded on the new socialist science of mashinovedenie, or 'critical technology'. Gastev's work was clearly the inspiration, but Dol'nikov was mildly critical of Gastev for his alleged kustar approach, neglecting the benefits of mass flow production. Dol'nikov concluded with a call for the construction of 'machine building 'kholkhozy''.²

In October 1931 the 'ultra-specialisers' launched a new campaign aimed at making 1932 a year of specialisation and cooperation with a view to obtaining the incorporation of specific projects based on these principles in the Second Five-year Plan.³ This was a three-pronged attack, involving representatives of the Communist Academy, Gosplan and the newspaper Ekonomicheskaya Zhizn'. The multi-shop factory basic to the capitalist economy had outlived itself the paper confidently asserted⁴, while Rudakov (Gosplan), one of the leading activists of the campaign, declared that, 'only by specialisation and cooperation on these lines (specialisation by parts and cooperation - JC) can we overtake the capitalists technically and economically in ten years'.⁵ Despite the stress on parts specialisation, all the successes of the campaign reported in 1931 and early 1932 were examples of process specialisation.⁶

1. ibid., p. 68.

2. Puti industrializatsii, 1931, No. 14, p. 22.

3. Ek. Zhizn', 20.10.31.

4. ibid., 14.10.31.

5. ibid.

6. ibid., 16.11.31; 14.3.32.

Early in 1932 the first serious, public, theoretical counter-attack against the 'ultra-specialisation' tendency was launched. Writing in Bol'shevik, M. Reisler, NKTP, sharply criticised Sorokin for seeing specialisation and cooperation as the primary factors in the development of the Soviet economy and rejected Sorokin's counterposing of specialised parts producing factories to 'universal' enterprises. Sorokin's incorrect views were ascribed to his uncritical absorption 'of all he saw, heard and read about America', his uncritical application of the experience of the motor industry to other branches (like machine tool building), and his one-sided stress on the construction of new factories to the neglect of specialisation and cooperation in relation to existing industrial structure.¹ Reisler himself was cautious in his assessment of the desirability of extending specialisation, although he was not against it and did favour the building of regional central foundries. Reisler is reported to have ^{argued} against the building of new specialised factories, ^{for} and limitation of further specialisation to semi-fabricates production at a major meeting in March 1932 at which representatives of NKTP, Gosplan, research institutes and other interested parties discussed plans for specialisation, cooperation and the geographical allocation of machine building. At this meeting the main report was delivered by Perel'man, who once again argued against 'closed' enterprises and for the further development of specialised factories for parts and processes.²

This contribution of Reisler provoked a bitter public exchange between him and another specialist, Igishev, which continued into June. In the course of it Reisler sharply attacked Sorokin for 'paper schemes': he had, Reisler declared, created, "pictures of 'ideally' and 'rationally' built enterprises in space" instead of providing concrete analyses of the specific preconditions for specialisation and cooperation in each branch.³ Igishev also criticised Sorokin for exaggerating the significance of specialisation and cooperation, but also considered that Reisler was conservative in his estimation of the scope for application of these principles during the Second Five-year Plan, later describing him as a 'harmful 'equilibrist''.⁴ In Igishev's view Reisler was incorrect because in the Second

1. Bol'shevik, 1932, No. 1-2, pp. 92-93.

2. Ek. zhizn', 14.4.32; 12.6.32.

3. ibid. 8.4.32; 12.6.32.

Plan technical reconstruction would be completed and "the scale of production will assume truly gigantic proportions. The share of mass-flow production will grow immeasurably in this interval of time".¹ These were assumptions basic to the position of all the 'ultra-specialisers', and Reisler not unfairly responded by claiming that Igishev's position was in essence the same as Sorokin's.²

A useful step in the struggle for greater clarity and realism in the discussion on specialisation and cooperation was a major article by Pepper, Sukharevskii and Kholmyanskii published in Planovoe Khozyaistvo. In a balanced review of the main positions Pepper criticised a number of extreme views and also set out the objective difficulties facing Soviet industry in developing specialisation of production. The latter included the inherited structure, the problems stemming from attempts to reduce the product range at the same time as new complex types of products were being introduced, the inadequacy of the production base in conditions of a rapid growth of demand for machines, and finally conservatism and 'wrecking'. Reisler was criticised for underestimating the significance of parts specialisation and cooperation, and Sorokin's characterization of the auto-tractor factories as 'universal' was dismissed on the grounds that these enterprises were in fact highly specialised because they produced only one type of machine on a large-scale permitting economic production of many parts within a single 'combined' enterprise. Sorokin's solution would simply lead to an undesirable proliferation of small factories. The tendency which called for the taking of specialisation 'to its logical conclusion' (Perel'man and others) was bluntly rejected: "The degree of realisation of specialisation at each stage of our industrialisation depends not on 'logical demands', not from so-called 'principles' and 'immanent laws' of specialisation, but on the development of the productive forces, on the level of concentration, on whether mass production is possible or is already predominant, on whether there is only individual production, on the level of standardisation, and on the general level of planning".³

Realism was beginning to return to the discussion.

1. Ek. zhizn', 8.4.32.

2. Ibid., 8.6.32.

3. Plan. Khoz., 1932, No. 3, p. 103.

By the autumn of 1932 the extreme positions of the 'ultra-specialisers' appear to have been generally rejected and a more considered and differentiated approach adopted. This new approach was exemplified by a contribution by Kurskii in September, which reviewed the debate and outlined future prospects for the practical development of specialisation and cooperation. Kurskii criticised Perel'man and Kritsman¹ for their schematic approach to specialisation and resort to superficial arguments in general terms: what was required in Kurskii's opinion was the elaboration of the question of stages of specialisation and cooperation of new and existing factories in accordance with the level of development of the productive base of machine building itself. The development of specialisation by parts required the provision of necessary productive capacity, the development of transport, and a high level of planning, and could only be tackled by looking at the specific circumstances of each individual branch and region.

Reviewing progress during the First Five-year Plan period Kurskii acknowledged that with the exception of the auto-tractor industry (in which over one hundred enterprises were involved in cooperation, those within the branch being of a specialised nature), cooperation in the engineering industry was then only to an insignificant degree based on factories specialised by parts. This situation was explained by the necessity, at the given stage of assimilating production in basic branches of machine building, of constructing technologically closed machining-assembly factories, concentrating the production of all basic parts. Despite its weak development Kurskii believed that the preconditions for further specialisation of production by parts had been created. The inadequate development of parts specialisation was in his view beginning to hinder the development of cooperation: the inadequate production base was fostering a tendency for factories to make items for themselves which could be produced at much lower cost at specialised enterprises. But Kurskii stressed that expanding

1. Kritsman appears to have been out of favour by this time because of views on the question of the location of industry during the Second Five-year Plan - see Plan, 1936, No. 3, p. 41.

the production base alone was not the answer; there also had to be an improvement of production organisation, a strengthening of interbranch planning and, as a first priority, a strengthening of khozraschet. Kurskii singled out machine tool building and the making of agricultural machinery as two branches which would require further development of parts and assemblies specialisation during the next five-year plan.¹

From the end of 1932 debate of general questions of specialisation and cooperation greatly diminished.² The Second Plan itself was certainly not founded on the far-reaching application of the principles as the 'ultra-specialisers' had demanded in 1931-32. It did call for further specialisation and cooperation, but placed the main emphasis on process specialisation. Enterprises created during the First Five-year Plan for the production of certain parts (bearings, chucks, chains, etc) were to be further developed, and at the same time the specialised production of a number of parts in mass demand common to many branches of engineering was to be organised, e.g. gears, shafts, fittings and fasteners. This would provide a basis for the growth of cooperation. Thus the idea of pure assembly factories had no place and the parts which were to be produced at specialised factories were of a type widely used throughout the engineering industry.

General questions of specialisation and cooperation almost disappeared from public debate for three years and interest only revived with the approach of the Third Five-year Plan. Ordzhonikidze stressed the importance of developing cooperation at the NKTP Soviet in 1935, but this did not give rise to any practical campaign³, but at the Soviet in the following June the first shots were fired in a new drive to extend parts specialisation and cooperation. At the session of the Soviet Pudalov, chairman of the technical council of NKTP⁴, made a powerful plea for the further development of cooperation in Soviet machine building. At that time, he observed, everyone shied away from it 'like the devil

1. Ek. Zhizn', 2.9.32.

2. An exception was Kholmyanskii's review of specialisation and cooperation in a number of branches of engineering published in 1933. This provided a sober assessment of achievements a future prospects, with frank acknowledgement of the objective difficulties. - Kholmyanskii, I., Spetsializatsiya i kooperirovanie mashinostroeniya v pervoi pyatiletke, M.-L., 1933.

3. Ordzhonikidze, G.K., Stat'i i rechi, M., 1957, Vol. 2, p. 680.

4. A. Pudalov had long industrial experience; he was chief engineer at the Putilov Works before the Revolution, one time director of the Stalingrad tractor factory and later head of Glavmashprom.

from holy water'. Examples of successful cooperation in the American machine tool industry were cited and the benefits in terms of full utilisation of capacity and cost reduction stressed.¹ A month later Pudalov continued what was clearly a campaign by the technical council with an article in which he observed that the engineering industry had still not renounced the practice of carrying out the entire production cycle in one factory. Now the time had come to take the path already taken by the American, German and British industries. Glavki were enjoined to draw up plans for the specialisation of production of parts, assemblies and accessories; this above all applied to the machine tool industry and auto-tractor branch. The production of such items as spindles, control levers, gears, pistons, bearings and other standard parts could be concentrated at specialised factories and Pudalov made the radical suggestion that the process could be aided by the organisation of trade in such parts. Finally, he raised the possibility that a large share of these items could be produced by the industrial cooperative system of local industry under the 'patronage' of the corresponding branch.²

Shortly after Pudalov's article two of the main protagonists of the earlier discussion added their voices to the campaign for the development of specialisation and cooperation. Perlov, also a member of the NKTP technical council, called for the development of standardisation of parts on a branch basis giving the possibility of organising mass, specialised production.³ Sorokin also returned to the theme of extending specialisation: if you ~~take~~^{took} a typical Soviet enterprise, he observed, then one was struck by the fact that together with the basic production shops there was a multitude of auxiliary shops, and a tendency towards kustar work and 'universalism'. Planned specialisation and cooperation was, he concluded, an urgent necessity.⁴ While there was an element of implied retrospective self-justification in Sorokin's contribution, in general the new discussion took a very different form from that of five years earlier: the abstract general theorising was now absent and future developments were

1. Sovet pri NKTP, Sten. Otchet., M., 1936, p. 157.

2. Za Ind., 28.7.36.

3. Plan. Khoz., 1936, No. 8, p. 49.

4. Bol'shevik, 1936, No. 16, pp. 45-52.

outlined in concrete and realistic terms. As will be shown the machine tool industry was very much involved in this second round of pressure for specialisation and the development of cooperation in the engineering industry, which continued into 1937.

In the contributions of 1936-37 there was an additional important argument in favour of the further development of specialisation and cooperation which had not been employed during the First Five-year Plan: its role in securing flexibility in the event of product changes. Thus Kogan, calling for the construction of a number of specialised factories on a parts and process basis, observed that during the Second Five-year Plan most new enterprises had been built with a full set of production shops as factory-giants, each individual shop employing up to 2-3,000 people and representing in effect a factory in itself, whereas what was now required, he believed, were specialised factories employing 3-5,000 people which could be built in a short time and would provide flexibility in the event of transition from one type of machine to another.¹ This point was also stressed by Kurskii in a call for further development of parts specialisation.²

Pressure for the further development of specialisation and cooperation in the engineering industry continued during the Third Five-year Plan; now with a much more explicit strategic dimension. Policy was presented at the Eighteenth Party Congress in March 1939 by Molotov and Malyshev, commissar of heavy machine building. Excessively narrow specialisation was condemned, and emphasis placed on intra-regional specialisation and cooperation. Malyshev was very critical of the inadequate level of cooperation and the attitude of many factory and branch leaders towards fulfilling orders on a sub-contract basis, although he conceded that the breaking up of the commissariats had undoubtedly made cooperation more difficult. Gosplan was criticised for its alleged lack of activity in fostering cooperative links between enterprises and branches, and Malyshev called for the formation of a new high-level body to take responsibility for the

1. *Problemy ekonomiki*, 1937, No. 3-4, pp. 40-41.

2. *Ibid.*, pp. 190-191.

problem, preferably attached to Ekonomsovet. It was also evident to Malyshev that it was necessary to take measures to stimulate the fulfilment of cooperation orders and production not provided for in the plan. In order to achieve this it was, he believed, necessary to establish prices which would stimulate the fulfilment of such orders and, possibly, introduce a special bonus system for factory and shop leaders.¹ It seems probable that at this time the problem of cooperation had assumed particular importance and urgency because many civilian machine building enterprises were being given additional special military orders, frequently for products not directly related to those normally produced. Malyshev's proposals do not appear to have been implemented. The splitting up of commissariats in the machine building-defence industry branches appears to have caused considerable difficulties for cooperation: Berri, writing in late 1940, reported that cooperation had become very complicated as sub-contracting relations established within NKs became transformed into inter-NK relations, which were then broken as commissariats strived to carry out cooperation solely within their own limits. Berri called for the strengthening of the Gosplan and Ekonomsovet apparatuses in order to combat this harmful tendency.²

Specialisation by Parts in the Machine Tool Industry

In the 1920s the limited machine tool building activity was almost entirely self-contained in the sense that the machine building enterprises involved made all parts and assemblies themselves. At this time the machines were not fitted with electric motors, hydraulic mechanisms or precision ball and roller bearings: the low technical level reduced reliance on outside suppliers. There does not appear to have been any proposal for specialising the production of any parts associated with machine tool building until May 1929, when the NKRKI recommended that the making of certain standard items such as fasteners (nuts, bolts, washers, etc.) and controls (levers, hand wheels, etc.) should be centralised at a specialised enterprise, thereby freeing space at the main factories.³ No action was taken at

1. XVIII s"ezd VKP(b), Sten.otchet., M., 1939, pp.301;388.

2. Plan.Khoz., 1940, No.11-12, p.147.

3. Ek.Zhizn', 19.5.29.

this time, and in none of the articles by representatives of the industry in the second half of 1929 and the first half of 1930 was the possibility of specialisation of parts production raised. Al'perovich was, however, well aware of the widespread practice of sub-contracting for parts and assemblies in the American engineering industry¹, so that his silence on the subject probably indicates that he believed it premature for the Soviet machine tool industry.

Shortly after the Sixteenth Party Congress Kaganovich raised the question of specialised parts production in the branch. Following the example of the American machine tool industry firms should be free from the making of standard items, lubricating mechanisms and drive fittings, he wrote, and orders for these parts given in a centralised manner to kustar workshops and other machine building enterprises.² The first evidence that Stankoob"edinenie was seriously thinking in this way came in January 1931 at the All-Union meeting on machine tool building - the meeting acknowledged the enormous importance of the standardisation of parts and the freeing of factories from making standard items, and welcomed the decision by the board of the ob"edinenie to concentrate the making of standard items at one specialised factory.³ It was possibly this decision which led to measures for the equipping of a specialised machine tool chucks and accessories factory, 'Stankopatron', in Murem. By this time debate on specialisation and cooperation had broken out in the press, a prominent role being played by Sorokin, head of Stankoimport. Therefore, it was not surprising that he very quickly set out his ideas on the subject in relation to the machine tool industry itself.

Sorokin's arguments on the question of specialisation and cooperation in the machine tool industry closely matched those in relation to the motor industry. A machine tool as an object of production was, in his view, no different from a vehicle; both were no more than collections of parts and assemblies. Therefore, in principle there was no reason why the building of machine tools could not be

1. Torg-prom.gaz., 31.12.27.

2. Za ind., 24.7.30.

3. SI I, 1934, No. 10, p. 6.

organised on the basis of specialisation and cooperation as in the motor industry. Foreign machine tool building could not do this however, he claimed, because of the anarchic nature of the capitalist system, competition between enterprises, product differentiation and the consequent small scale of production. Furthermore, abroad the machine tool industry had developed before the motor industry and acquired a complex structure formed over decades. In the Soviet Union with conditions permitting the mass production of commonly met types the situation was quite different and favourable to the development of specialisation and cooperation. Thus the machine tool industry, he believed, had to organise specialised production on a large-scale basis of gears, standard items, pumps, accessories, electrical equipment, a number of small parts, safety devices, forgings, stamped parts and castings. Moreover, a very large factory was required for making jigs and fixtures. Sorokin regretfully noted that this principle had not been adopted either in relation to existing enterprises or new and, echoing his earlier characterisation of the auto-tractor factories, he remarked that, "As far as I know, the projected factories of turret lathes and milling machines are by the scope of their production universal enterprises".¹ Finally, as noted elsewhere, Sorokin called for production cooperation of a different kind - the supply of parts and assemblies by foreign firms until their domestic production had been organised.

This radical proposal met little response from leaders of the branch and plans for the development of specialised parts production were of a modest nature. In November 1931 Al'perovich noted that in the conditions of the planned economy the branch had the possibility of a maximum standardisation of parts and the organisation of the production of standard items at special factories.² This view was later reflected in the NKTP order of June 1932, which stated that factories for the production of standardised parts, regional factories for gears and factories for attachments and accessories had to be provided for in the investment plans for the next five-year period.³ At the conference of designers

1. ZaInd., 16.2.31.

2. SII, 1931, No. 11, p. 3.

3. SII, 1932, No. 7, p. 2.

which followed the order Al'perovich again returned to the question, but this time put the main emphasis on the need for preparatory work before cooperation could be successfully realised. It was essential, he stressed, to carry out standardisation and other measures securing interchangeability of parts: little had been done in this direction to date. Serious persistent work of all designers was in Al'perovich's view the 'sole precondition' for the effective realisation of "our basic policy in the next Five-year Plan - the policy of maximum cooperation of factories and the separating off of special factories and preparatory shops - foundries, forges, factories making all required accessories for machine tools, factories for making standard fixtures and, in particular, a factory which will make gears for our machining-assembly factories".¹

At this time active measures were in fact being taken to organise the specialised production of standard items and gears. The im.Dzerzhinskogo factory in Perm began to prepare large-scale production of fasteners, gears, pumps, chucks and other accessories for the branch as a whole.² This plan was abandoned, however, when the enterprise was transferred to another administration before 1933. In the summer of 1932 it was announced that the plan of specialisation of machine building for Nizhni-Novgorod krai during the Second Five-year Plan provided for the construction of a specialised gear-making factory to serve the whole machine tool industry³. Also in 1932 the 'Stankopatron' factory started work. This enterprise was commissioned quickly because it used the building of an old textile factory and equipment from a bankrupt German firm, 'Samson Werke'. Its main product was chucks for machine tools, but it also made some accessories and standard fixtures.⁴ By 1932 the branch was being supplied with electric motors on a regular basis from enterprises of the electrical engineering industry, notably the Moscow im.Lepse works, the Khar'kov electro-mechanical factory and the Leningrad 'Elektrosila' works.

1. SI, 1933, No. 1, p. 3.

2. Lebyachenko, op cit, p. 32.

3. Ek. zhizn', 23.6.32.

4. Lebyachenko, op cit, p. 33.

With the transition to the third phase of the industry's development, Al'perovich began to pose the task of developing specialised parts production and cooperation as one of the means of realising the policy of rapidly expanding the tipazh, but as the conference of machine tool builders in July 1933 demonstrated this course did not have general support at the factory level. The NKTP order instructed Stankoob"edinenie to organise in 1933 the centralised production of basic standard items (fasteners, levers, handwheels, etc.)¹ Discussion at the conference, on the few occasions the topic of cooperation was raised, focused on obstacles to its realisation. Al'perovich in his opening report admitted that opposition to fulfilling cooperation orders was not simply a matter of conservatism on the part of factory managers, but an anti-cooperation psychology induced because in no branch of machine building was there a correct attitude to meeting the needs of customers.² Factory representatives made a similar point. Krupnyshev of the im.TsK Mashinostroeniya factory blamed NKTP for the poor level of development of cooperation: "...if from this moment there is a change of policy on the part of NKTP in relation to enterprises which have in view cooperation; if a policy of pressure (nazhim) is not pursued, then we will be able quickly to carry out cooperation".³ But Zhbakov, the director of 'Krasnyi Proletarii', was much more sceptical and in a colourful speech summed up what was probably the attitude of many managers in Soviet industry at this time. In his view policy for cooperation was in many respects mistaken. Referring to cooperation for the supply of castings, gears, etc., he claimed that: "...such cooperation now, in our conditions, for the next five years could bury machine tool building". He believed that those who proposed the idea of supplying all the gears required by the industry from Gor'kii must be joking. Zhbakov added that he understood the type of cooperation used when two factories worked together to produce large machine tools, but 'nothing would come' from producing parts of one type in a single place. At present, he added, he was already receiving chucks from one factory but they were 'no good for the devil'.⁴

1. Industrializatsiya SSSR, 1932-1937, p.249.

2. Stenogrammy, op cit, pp.33-34.

3. ibid., p.60.

4. ibid., pp.70-71.

Al'perovich returned to the question of the attitude of enterprises to cooperation orders shortly after the conference, when he sharply criticised the 'utterly disgraceful relationship' of factories towards orders from other factories. If an enterprise was obliged to make, say, gears for a second factory then they were usually supplied in such a disgraceful way and of such poor quality that any desire to resort to further cooperation was immediately killed, and the second factory then strived to obtain resources in order to make the gears itself. This attitude, Al'perovich concluded, was a remnant of the psychology, "stand in the queue and wait to see what happens".¹

After the All-Union conference and, in fact, until the end of 1934 there appears to have been little if any action on the question of parts specialisation and cooperation, and it was hardly mentioned in articles in the press on the industry. The problems of castings supply and transport² may well have fostered and reinforced a widespread hostility towards the centralisation of production of parts and semi-fabricates such that the Glavk felt disinclined to raise the matter. One exception to this rule was a call by Al'perovich in April 1934 for action to free the machine tool industry from dependence on the electrical engineering industry - the very reaction he himself had condemned in relation to individual factories of his own glavk was, apparently, acceptable for the glavk in relation to other branches. Al'perovich urged the necessity of rapidly organising within the glavk a factory with its own design bureau for making special small motors and all electrical accessories.³ Action was in fact taken in the following year.

A turning point in discussion of specialisation and cooperation policy for the machine tool industry came at the end of 1934 when a number of leading representatives of the industry visited Britain for the Olympia machine tool exhibition. Reviewing their impressions of the British machine tool industry Kaganovich and Al'perovich stressed both the close relationship between the industry and electrical equipment firms and the existence of a large number of

1. *Sotsialisticheskaya rekonstruktsiya i nauka*, 1933, No. 8, pp. 169-170.

2. Al'perovich noted the role of transport problems in frustrating cooperation in May 1934 - *ZaInd.*, 27.5.34.

3. *ZaInd.*, 26.4.34.

small firms servicing the machine tool factories by supplying pumps, standard items, fittings, chucks, chains, signal lights, etc. "This yet again emphasises", they concluded, "that the rapid development of the machine tool industry during recent years has been linked with the work of various other branches of industry".¹ The lesson for the Soviet machine tool industry was clear: "without a full-scale base of allied production it is impossible to develop modern machine tool building". This lesson was reiterated by Kaganovich two months later and he called on the branch to organise the specialised production of electrical equipment, some types of bearings for high-speed machines, pumps and standard items.² Levin, director of ENIMS, also supported this line claiming that in Western European and American machine tool building about thirty per cent of all parts were obtained in finished form from allied suppliers permitting better production organisation and reducing costs. He also called for the organisation of specialised production of electrical equipment and bearings.³

Despite this propaganda for specialised production and cooperation, action in 1935 was restricted to the supply of electrical equipment. This problem of inter-branch supply seems to have been particularly acute at this time. In 1934 it was reported that the Khar'kov electro-mechanical factory, the sole supplier of button control units, was planning to meet only 60 per cent of the industry's needs, forcing the factories to make their own.⁴ In April 1935 Lapin, chief engineer of the GUSIF complained that Glavenergo was supplying electrical equipment of insufficiently modern design and inadequate quantity so that no less than 2,000 machine tools built in the previous year were still without motors. When challenged the head of Glavenergo, Filimonov, is reported to have replied that: "In 1935 we will meet 75-80 per cent of the demand of machine tool building for motors and starters - we consider that this amount is sufficient".⁵ This situation forced the machine tool industry to place orders

1. *ZaInd.*, 6.1.35.

2. *Bol'shevik*, 1935, No. 6, p. 16.

3. *Plan. Khoz.*, 1935, No. 7, p. 27.

4. *ZaInd.*, 16.3.34.

5. *ibid.*, 20.4.35.

with small workshops and promcoops with no previous experience resulting in low quality and high costs.¹ By the end of 1935 GUSIP had decided to produce its own electrical equipment at a factory in Khar'kov, 'Elektrostanok'. This small specialised enterprise began work in 1936 under the technical leadership of the laboratory of electric drive of ENIMS, and by the beginning of 1937 Al'perovich was reporting that it had already given a number of important products which the industry had been unable to obtain from the Khar'kov giant.²

In 1935 there were signs that the approach of the machine tool industry towards specialised parts production and cooperation was beginning to change; in 1936 the question came to occupy a central place in policy discussion, not only in the branch but, as related above, in the engineering industry as a whole. In this case it appears to have been the machine tool industry which played an independent role in bringing the issue to the fore. It was the Fourth Conference of Designers in April 1936 which brought questions of specialised parts production and cooperation to the forefront, closely associating them with securing conditions for technical progress. Shortly before the conference Levin observed that the quality of Soviet machine tools still lagged far from foreign standards partly because such items as fasteners and controls were made by the factories themselves, whereas abroad sub-contractors were responsible for their production and at the same time performed a relatively independent innovatory role.³ At the conference Dikushin, a leading engineer of the branch, gave a report on the American machine tool industry. This was not published at the time, but in later article apparently based on his conference report, Dikushin emphasised that the achievements of American producers were possible thanks to the good work of 'allied' branches of industry, notably those concerned with hydraulics and electrical equipment. "Generally speaking," Dikushin wrote, "one has to say that today's innovations which are completely changing the design of machine tools, have been created not by the machine tool builders, but by the hydraulics and electrical producers...But we have not yet even been able to get

1. Dependence on small factories of local industry could be hazardous because their priorities were not necessarily those of heavy industry, e.g. in 1936 Levin reported that a small Leningrad factory specialised in the making of gauges and indicators for which there was a large demand in the machine tool industry. But
cont. next page..

good bolts from our sub-contractors".⁴ Thus a new argument in favour of the development of specialised parts and assemblies production came increasingly to the fore: specialisation gave the possibility of promoting technical progress. In the resolutions of the conference the Glavk was urged to organise special factories and shops for the making of standardised hydraulic drive elements, special electrical apparatus, spindles for internal grinders, fittings, etc.⁵

A major turning point in the campaign for the development of specialised parts production and cooperation came with the Soviet of NKTP in June 1936. As related above, at this meeting Pudalov made a plea for the development of cooperation, drawing on the experience of the American machine tool industry. In his speech to the Soviet Al'perovich also spoke on the topic, admitting that "Everyone agrees in principle that cooperation is necessary, but in practice we sabotage it". However, he was convinced that the level of development was now such that the practical problems could be solved.⁶ Shortly after the Soviet the Glavk outlined its plans for improving the situation: small batch and individual production of special electrical apparatus was to be organised at the 'Elektrostanok' factory; a special shop for making precision spindles and centres for high-speed machines was to be organised at the 'Kalibr' tooling factory, which was also to make appropriate high-precision bearings; ~~production of~~ hydraulic elements were to be made at a factory in Khar'kov; and, finally, the production of fasteners was to be organised at the Moscow 'Stankonormal' factory. In outlining these plans Al'perovich put forward a proposal for fostering a desire to cooperate at the factory level: "The fulfilment by factories of cooperation orders should be specially stimulated and serve as one of the independent indicators of plan fulfilment".⁷

the local industry administration to which it was subordinated wanted to stop this production in order to make clockwork mechanisms for toys! (ZaInd., 6.4.36)

2. ZaInd., 9.1.37; SiI, 1943, No. 9-10, p. 4.

3. ibid., 6.4.36.

4. ibid., 6.8.36.

5. SiI, 1936, No. 6, p. 6.

6. Sovet pri NKTP, op cit, p. 144.

7. SiI, 1936, No. 8, p. 6.

The Soviet was followed by a flurry of activity in the branch, including the convening of a special conference at which problems of specialisation and cooperation were discussed and a special system of bonuses elaborated to provide an incentive for factories to reveal unused equipment and put it to use making parts required by other enterprises.¹ At about this time quite extensive cooperation was organised for the production of special machine tools urgently required for the tractor factories.² The issue of specialisation and cooperation occupied a large place in discussion of the branch's technical plan for 1937, but not enough to satisfy at least one critic. Khavin launched a sharp attack on the Glavk's leadership for its alleged neglect of the possibilities of cooperation and called for the narrow specialisation of factories on the production of individual parts and assemblies and the development of very wide cooperation.³ These arguments were reminiscent of Sorokin's proposals of the First Five-year Plan period, but they do not appear to have found much support.

At the end of March 1937 a special meeting was held on the problem of cooperation in the machine tool industry with the participation of the deputy Narkom of heavy industry, Bruskin, Al'perovich and a number of factory directors and representatives of ENIMS and allied branches of industry. Topics discussed included the supply of bearings, the quantity of which was satisfactory, but not the range, especially of precision types. Furthermore, the technical specifications of those produced by GPZ1 and GPZ2 did not even conform to branch standards (OST); this last shortcoming was to be rectified. The supply of electrical apparatus was deemed inadequate and there was a call for the organisation of small specialised factories to make various metal items.⁴

With the replacement of the branch's leadership and the general disruption of 1937-38 the campaign for specialisation and cooperation seems to have subsided. The situation in the branch at the end of the Second Five-year Plan period will now be briefly reviewed. Electrical equipment was basically supplied by the electrical engineering industry, except for some types of special equipment

1. ZaInd., 3.8.36.

2. Ibid.

3. Ibid., 28.9.36.

4. Ibid., 1.4.37.

made within GUSIP by the 'Elektrostanok' works in Khar'kov. The first Soviet machines with hydraulic drive mechanisms were produced by the Khar'kov machine tool factory from about 1935. In the following year it was reported that a factory was being equipped in the city (apparently attached to the Khar'kov tooling works) for the centralised production of a full range of hydraulic equipment required by the branch.¹ In 1937 'Gidroprivod' started work, but according to a report in 1938 its product range covered only 10 per cent of requirements.² Bearings needed by the industry were supplied by the two main bearings factories, GPZ1 and GPZ2 of the specialised bearings industry. In the course of the 'thirties there were mounting complaints that the precision bearings required by high-speed machine tools were not being supplied in adequate quantity and quality. Early in 1936 Al'perovich indicated that a special shop for making precision bearings and spindles was to be established at the 'Kalibr' measuring instruments works, but later in the year Lapin announced that the Glavk had decided instead to equip a special shop at the 'Stankokonstrukt-siya' factory for making precision bearings from parts supplied by GPZ1. Careful selection and matching of components to high standards of accuracy would, it was believed, permit greater precision than was obtainable from the larger enterprise.³ It is not known whether this scheme was realised. Presumably the machine tool industry was competing with the aircraft industry and other top priority military related branches for precision bearings and suffered accordingly.

By 1938 the position with regard to standard fasteners was rather more satisfactory. In 1936 the Glavk managed to secure the transfer of a factory of Remmashtrest in Moscow at which the production of all types of standard items was to be organised, in particular fasteners and controls.⁴ This factory, 'Stankonormal', began work in 1937 and in the same year additional capacity was also organised at the im. Ordzhonikidze works. The 'Stankonormal' factory also began to build machine tools (internal grinding machines) and fears were

1. ZaInd., 3.8.36

2. Plan. Khoz., 1938, No. 9, p. 51.

3. ZaInd., 3.8.36.

4. Ibid.

expressed that the production of fasteners would be sacrificed. However, it was resolved that fulfilment of the plan for standard items was to be an essential precondition for a positive evaluation of the whole enterprise's performance.¹ The centralisation of fastener production allowed the use of progressive technology and greatly reduced costs, e.g. cold-upsetting methods were used for making bolts giving an output of 15,000 units a shift, compared with only 200-250 a shift at the im.Ordzhonikidze factory where turret lathes were employed, while fasteners produced on a small scale at the 'Komsomolets' factory cost 8-10 times more per unit than those made at 'Stankonormal'.² However, 'Stankonormal' was unable to meet all the requirements of the branch: in 1940 it was to make 18 million units against a total demand of 32.6. By 1940 specialised production had also been established at the Kiev im.Gor'kogo factory, and this enterprise together with im.Ordzhonikidze was to give a further 2.8 million units, leaving 12 million units to be supplied by factories themselves on an unspecialised basis.³ Finally, chucks and other accessories were made by the 'Stankopatron' factory in Murom. There were few reports of its activities during the period, but Berri laconically observed in 1938 that it produced low quality chucks which the machine tool factories had to remake.⁴ There were no other factories in the Glavk for making machine tool accessories and no specialised factory for making fixtures.

During the Third Five-year Plan years policy with regard to specialisation and cooperation did not change, but the momentum built up in 1936-37 appears to have diminished. In 1939 two small Leningrad factories were transferred to the branch: one for the production of dividing heads, and a second factory, 'Stankoprindlezhnost', which produced vices, hydraulic chucks and mechanical stepless drive units for machine tools.⁵ According to an editorial of Stanki i Instrument in September 1939 the industry was planning to organise a shop for producing gears at one of the gear-cutting machine building factories; the production of electric pumps was to be expanded at a factory of the cooperative

1. SI, 1938, No. 10., p. 48.

2. Mashinostroenie, 10.7.40.

3. ibid.

4. Plan. Khoz., 1938, No. 9, p. 49.

5. Leningradskaya promyshlennost' za 50 let, L. 1967, p. 231.

system in Moscow, and drive chains were to be made in greater quantity for the branch by another Moscow enterprise. It is not known whether these measures were carried out.¹ In the same month the major SNK decree on the industry also called for the construction of new factories to supply parts for machine tools, including three new enterprises for making fixtures and standard items and a factory of chucks.² There is no evidence that these factories were in fact built. Thus with the development of the industry in the Second and Third Five-year Plans some progress was made in developing parts specialisation and cooperation, but this progress was of a quite limited nature: only the first steps away from the 'closed' enterprise had been taken.

Some General Considerations

Specialised parts production in the Soviet machine tool industry by 1941 was underdeveloped compared with the practice of Western Europe and the USA. It was also considerable less extensive than had been desired by some specialists in the First Five-year Plan period. But if we look at performance in the light of real plans which the machine tool industry adopted at various times we see that the discrepancy between intention and realisation was not so great: real plans never envisaged the mass production of standardised parts and assemblies on the scale proposed by some specialists not directly concerned with the industry. Failures there certainly were; a specialised gear-making shop or factory was never established, centralised production of accessories was never organised on the scale desired, the production of standardised items on a centralised basis did not achieve the level foreseen earlier in the period.

The extreme 'ultra-specialisers' of 1931 and the first half of 1932 were clearly unrealistic and the criticisms of their positions advanced by such specialists as Reisler, Pepper and Kurskii in 1932, and later by Berri were just.

1. SII, 1939, No. 9, p. 5.

2. Direktivy KPSS i sovetskogo pravitel'stva po khozyaistvennym voprosam, M., 1957, Vol. 2, p. 602.

The ideas of Sorokin, Perel'man, Kritsman and others were indeed abstract and divorced from the actual and immediately realisable level of development of the productive forces and of planning. They were also harmful because, while their ideas were not in fact reflected in the Second Plan as adopted, they were for a time influential at an early stage in the preparation of this plan and many of the proposals at this time must have aroused the antagonism of practical workers in industry towards the very idea of parts specialisation and cooperation. There is strong evidence for this in the speeches of some contributors at the first All-Union conference in 1933. The exaggerated views of the 'ultra-specialisers' were a component of a widespread over-estimation of the achievable rate of development of the Soviet economy prevalent in 1931 and lasting, albeit in a weakened form, until about the autumn of 1932. However, if the case of the machine tool industry is typical, practical workers in industry (like Al'perovich) and representatives of NKTP¹ had throughout this period a more sober view of the desirability and feasibility of developing specialised parts production and cooperation in the short run.²

At the beginning of the First Five-year Plan the obstacles to the development of specialisation by parts were formidable. The planners did not start with a clean slate: the inherited industrial structure was one of universal enterprises, not specialised by type of machine, let alone by parts or processes. Furthermore, branch specialisation was very poorly developed in the engineering industry. Thus the establishment of rational branch and factory specialisation was an

-
1. No published evidence has been found indicating that either Ordzhonikidze or M. Kaganovich supported the 'ultra-specialisers'.
 2. This we believe relates to a major weakness of Granick's treatment of this problem: he does not analyse the stages of the specialisation debate and the rise and fall of the 'ultra-specialisation' tendency, and does not sufficiently differentiate the views of specialists put forward in the press and at general policy discussions, from the views and actions of those directly concerned with industrial management and planning. Thus we do not accept Granick's view that there was a large gulf between 'Soviet official opinion' and the 'realities of Soviet industrial organisation'-at least in the period in question (see Granick, *op cit*, p.153.) Symptomatic of Granick's inadequate differentiation of positions is his statement that: "A 1954 book attacked the 'harmful' prewar ideas of building specialised plants for the production of individual components" (*ibid*, p.152). This is quite untrue. Berri in the work concerned was indeed highly critical of the 'ultra-specialisers', but was far from being opposed to parts specialisation as such (see Berri, *op cit*, pp.250-253). Berri's views on specialisation of parts production and cooperation put forward in 1954 follow closely his 1938 views on these questions in relation to machine tool building (*Plan. Khoz.*, 1938, No.9).

essential first step and first priority of the Party and industrial leaders. Branch standardisation was at a very low level and interbranch standards for parts of machines almost non-existent. In the years of the First and Second Five-year Plans major problems remained. The need to rapidly assimilate complex new products and forms of production organisation in a very short period of time in a situation of inadequate skills and an acute shortage of investment resources and poor transport naturally favoured the building of large, vertically-integrated enterprises. And while skills rose quickly as these enterprises were assimilated, investment resources for building specialised parts factories were scarce and considerations of time tended to make the expansion of existing integrated factories a more practical proposition than the building of new. An additional factor which cannot be ignored is the fact that the relatively high level of factory specialisation by type of machine met in a number of branches of the engineering industry, including machine tool building, coupled with the large scale of production of homogeneous products, meant that economies of scale of within-plant production of parts and assemblies could be reaped in cases where specialised production on a centralised basis may have been a more economically expedient solution in other countries. This must to some extent have applied in the machine tool industry, especially during the First Five-year Plan. With the expansion of the product range which occurred during the 1930s the economic rationality of specialisation of parts production must have grown, but was frustrated by the inadequate production base and investment resources. We consider that these objective obstacles to specialisation by parts were the primary factors determining the level achieved in the machine tool industry before the War, and in view of these real problems it would hardly have been rational for the industry to have attempted to push parts specialisation much further than it did.

The greatest supply difficulties were those encountered when other branches of industry were involved. The most serious problems appear to have been those concerning the supply of electrical equipment from the electrical engineering

industry. Provision of even basic standard motors and starters was inadequate and the situation was worse for special equipment. The demands of the industry grew rapidly during the 'thirties and the technical level of products required grew considerably. The machine tool glavk was forced to organise its own small scale specialised production in order to meet some of the high-priority special demands, but this was clearly not a satisfactory solution. Whereas electrical equipment suppliers in the USA and other countries played an active innovative role and helped to raise the technical level of machine tools as a whole, in the USSR they appear to have reluctantly tailed behind the machine tool branch, playing a purely passive role. A similar situation was met with regard to bearings: normal requirements were adequately met, but precision bearings required in ever larger quantity as cutting speeds rose in the course of the decade were very poorly supplied. Hydraulic equipment represented a somewhat different case in so far as there was no established hydraulic equipment producing branch at the time so that from the start the branch was forced to organise its own production. These problems of interbranch supply can easily be explained. Interdepartmental barriers were evidently a major factor - ironing out problems required the mediation of NKTP or other high-level body. But another important factor appears to have been that the machine tool industry was quantitatively not a large customer for either the electrical engineering or bearings industries, and did not have large bargaining power. Furthermore, supplying branches seem to have retaliated at times for poor supply of machine tools from the machine tool industry; and frequently argued that inadequate machine tool supply was hindering the fulfilment of their obligations. An editorial in Mashinostroenie in 1940 asked the question - why was supply in the branch so bad? "Because many of them (suppliers), proceeding from narrowly departmental interests, and the fact that the machine tool builders' orders are frequently 'insignificant' by volume and promise less profit and more trouble, hook or by crook push them into the background and drag out their fulfilment for months and sometimes years. But how can they possibly be 'triflings' when one is talking of satisfying the vital needs for machine tools of our machine building and defence industry and,

in fact, all branches of the national economy"¹.

The question of cooperation is somewhat different with specific features and problems. 'Cooperation' took three forms. First, specialised production of parts or semi-fabricates in a special factory or shop, these items being supplied to a number of enterprises on a regular basis. Second, the use by a factory of spare capacity to meet the needs of another enterprise; such production was not necessarily specialised in the sense of employing specialised technology giving scale economies. Third, there was cooperation for the production of specific products on a once only basis, e.g. the building of special machine tools. This last form of cooperation was quite widely employed in the branch and for producing non-machine tool items at machine tool factories, e.g. tractor spares, equipment for the Metro, and components for military equipment later in the 'thirties. It was almost certainly unwelcome from the point of view of the factory, but such orders usually had government and Party weight behind them and their fulfilment had high priority. This form of cooperation, together with the second type, suffered greatly from inadequate planning. In fact cooperation orders were not really planned at all during the period in question, i.e. they were not provided for in the annual plan, but were regarded as an extra above-plan activity. The 1941 annual plan was the first to provide specific assignments for such orders.² This lack of planning made it easier for factories to avoid their obligations and led to the use of administrative methods to secure compliance. This shortcoming was at times acknowledged, e.g. Granovskii and Markus, writing in 1940, admitted that the poor planning of cooperation led to situations in which orders were fulfilled, "...exclusively under the pressure of the orderer, and under the threat of repression".³ This lack of planning plus the many other problems (transport, standards, interdepartmental barriers, etc.) coupled with the absence of any financial incentives for the fulfilment of cooperation orders, seems to have led factories to deliberate efforts to sabotage cooperation by supplying such poor quality products that the orderers preferred to make their own. In 1936 there were proposals for some form of regular bonus system for the successful

¹ Mashinostroenie, 14.9.40.

² Berri, op cit, p.257.

³ Granovskii, E.L.; Markus, B., Ekonomika sotsialisticheskoi promyshlennosti, M., 1940, p.268

fulfilment of cooperation orders and this demand was repeated by Malyshev at the Eighteenth Party Congress, but there is no evidence that action was taken. It is quite probable, however, that there were some one-off bonuses for the completion of specific projects on a cooperation basis.

The lack of planning and incentives for cooperation during the 1930s also may have in part reflected an oversimplified theoretical understanding then prevalent. There appears to have been a belief on the part of planners and others that the socialist planned economy by its very nature would lead to the successful realisation of cooperation: preconditions were confused with actual possibilities, and the real problems of realising these preconditions not fully appreciated. There is a definite hint of such a misconception in Ordzhonikidze's declaration at the 1935 Soviet of NKTP: "What is cooperation? This means that an enormous number of enterprises act at one command for solving a single task, helping one another..... In all the capitalist world industry is split up into separate firms which struggle against one another with the utmost fierceness. Here industry is concentrated in a single fist, subordinated to a single will; we need to know only how to use it intelligently... Our factories must be imbued with a Bolshevik desire to help one another. Cooperation is an extraordinarily powerful lever in our hands. Of course, one needs to cooperate in a proper manner, and not like muddlers."¹ The problem was precisely that the objective situation of the enterprise was such that it had certain collective interests of its own, which did not necessarily directly coincide with those of the 'single will', while the 'Bolshevik desire to help one another' was in itself an insufficiently powerful motivating factor. This problem was related to the general underdevelopment of khozraschet mechanisms for bringing the interests of the enterprises more into line with those of the economy as a whole. Improved khozraschet relations with some form of financial compensation for the costs and inconveniences of fulfilling outside orders, together with penalties for non-fulfilment could have greatly improved the situation: from the suggestions in the press in 1936 it does appear that some industrial leaders were beginning to think in this direction, but this initiative was cut short.

¹ Ordzhonikidze, G.K., Stat'i i rechi, M., 1957, p. 680.

Chapter 2

It has been argued that the vertical integration which characterised the Soviet engineering industry in the pre-war years (and later) was an unintended consequence of the planning system itself as it operated at the time; a planning system which, because everything was subordinated to the single aim of maximum output, fostered a short term outlook and hostility to any form of regular dependence of one enterprise upon another.¹ We believe this to be an inadequate explanation, placing excessive weight on the role of the gross output plan indicator as a behavioural determinant. As noted above, the objective conditions of the Soviet economy of the 1930s were in many respects not conducive to the development of parts specialisation and cooperation - the inherited structure, lack of skills, limited investment resources, inadequately developed transport system, and later the demands of a rapid growth of military production, etc. In this situation the drive for maximum output, itself not simply a matter of preference but imposed to a large degree by external forces, could not but exacerbate the situation. At the same time the high rate of industrialisation, involving rapid development of the productive forces, created both the conditions requiring a further extension of the division of labour and preconditions for its realisation. It was this complex interrelationship which the 'ultra-specialisers' did not understand, but which came to be appreciated in the course of the 'thirties.

1. Granick, op cit, p. 170.

Chapter 7THE CHOICE OF MACHINE TOOL TECHNOLOGY

With the adoption of the policy of rapid industrialisation Soviet industry was faced with the question of which types of machine tools were most appropriate for use in the engineering and other branches and for production at Soviet machine tool building enterprises. This was a specific case of the more general problem of the choice of appropriate industrial technology which had exercised economists, technical specialists, industrial and political leaders during the second half of the 1920s¹. By the start of the First Five-year Plan the principle of building large new enterprises and reconstructing the old on the basis of the latest, modern technology of the capitalist countries had quite widespread acceptance; but this general policy injunction had to be translated into real life decisions specific to each branch of industry. What was the 'latest capitalist technology'? Some invoked 'progressive' American mass production and counterposed it to West European 'backward' universalism; others went further and considered all capitalist technology backward and inappropriate to the conditions of the Soviet, socialist economy. This problem had to be solved at a time when skills - technical, planning and managerial - were a scarce resource, and the pressure for quick solutions intense. This chapter is devoted to a consideration of the problem of technical choice as it related to the machine tool industry in the inter-War years.

Discussion of the choice of technology is usually conducted by economists in terms of factor endowment, the availability of capital and labour and their cost. In real life the choice of technology is not made by economists, or even by the planner (except in a very general sense), but by engineers and other technical, practical workers in design offices and enterprises. Furthermore, the terms of their discourse, as the case of the machine tool industry clearly demonstrates, are often far removed from those of the economist; the choice may in reality take a quite different form, being not between different degrees of 'capital intensity' or 'labour intensity', but between degrees of 'specialisation' or 'universality', between 'flexibility' and 'specificity', and between technologies

1. See Davies, R.W., "Aspects of Soviet investment policy in the 1920s", in *Socialism, Capitalism and Economic Growth*, (Ed. Feinstein, C.H.), Cambridge, 1967, pp. 285-307.

appropriate for use by workers of different skills and physical capabilities. These terms are not unrelated to those of the economist, but their relationship may be indirect or tenuous. The end result of what may in practice be purely technical decisions have economic significance, but the activity of choice cannot be directly assimilated to the 'choice' of economic textbooks.

The fact that Soviet policy was directed towards the use of the latest technology of the capitalist countries makes it necessary to analyse its development during the period in question. Soviet industry was faced with a pre-existing structure of machine technology: the stock of machines inherited from Tsarist Russia presented a spectrum of technical solutions, as did the range of machine tools actually available on the world market at the time the decisions on rapid industrialisation were taken. From this structure of machine tools the set most appropriate to the demands of the Soviet economy had to be chosen. The following section provides an analysis of the development of machine tool technology in the capitalist countries in the relevant period in order to reveal the nature of the structure of technical solutions facing Soviet industry.

The Development of Machine Tool Technology

In considering the development of machine tool technology a distinction must be made between the overall tendencies of development and the more ephemeral features conditioned by the state of the capitalist economies in the short run. Conjunctural factors have at times exerted a definite influence on the development of machine tool technology, but have not altered the main line of advance. Development has not proceeded as a smooth, evolutionary process, but a complex, dialectical process exhibiting stages of evolutionary and revolutionary change; the forward movement taking a spiral rather than a linear form. Three main stages can be distinguished. First, the initial stage of the widely universal machines; second, a stage of differentiation of operations and the specialisation and simplification of machines, leading to a third phase of concentration of operations and growing complexity. Each stage poses certain demands in terms of the skills required for the operation of the machines, and also tends to be associated with

certain characteristic forms of organisation. While the path of development has a logic inherent to the technology itself, the motive forces of change have been of an economic and social character stemming from the conditions of capitalist machine production. The main phases of development will now be briefly considered.¹

The early machine tools were of a universal nature capable of machining a broad range of workpieces and performing a wide range of functions; i.e. they had a low level of object and functional specialisation. In turn, machine operators needed a considerable range of skills and the accuracy of the work depended to a great extent on their skills: they were craft workers, requiring long training. Production at this stage was generally of an individual or small batch type. The universal lathe, boring machine or planing machine are typical examples of the machine tools of this first stage of development.²

With the gradual increase in scale of production which occurred with the development of capitalist machine production a process of differentiation and specialisation began, leading to the creation of new, more specialised machines, e.g. the milling machine, gear-cutting machine and automatic lathe. Later, even more specialised variants appeared, e.g. thread milling, copy milling and plano-milling machines. Both functional and object specialisation took place, the latter entailing a reduction of the range of workpieces machinable on a given machine. The progressive specialisation led to the decomposition of the production process and the machine began to incorporate an ever larger share of the skill previously the prerogative of the worker. The range of skills required by the worker consequently declined. The all-round mill-wright disappeared, giving way to the more narrowly specialised turner, miller, borer, etc. who still required, however, a quite high level of skill. But as the process of differentiation and specialisation

1. The general tendencies of machine tool development have been analysed in a number of works, notably, Kutta, F., *Chelovek, trud, tekhnika*, M., 1970 and Touraine, A., *L'évolution du travail ouvrier aux Usines Renaults*, Paris, 1955. The labour skills aspect has been considered by Cole, G. D. H., *Trade Unions and munitions*, London, 1923; and Gastev, A. K., *Kak nado rabotat*, 2nd. edn., M., 1972, pp. 224-293.

2. See Kutta, *op cit*, pp. 151-152; Touraine, *op cit*, p. 23.

deepened the worker was reduced to a machine operator able to work a range of different types of machine tool after only a brief period of training. This process allowed work of an ever greater precision to be obtained with the employment of workers of less and less skill. The ultimate expression of this tendency is the special purpose machine designed for fulfilling a single operation on one specific workpiece - here object and functional specialisation are most highly developed. The basic condition for the use of such machines is a scale of production adequate to secure a profitable level of utilisation and this entails changes in the system of production organisation characteristic of the phase of the universal machine.

During the stage when universal machines were predominant two basic forms of organisation of production were possible. First, machines could be grouped according to the type of equipment - functional organisation - giving shops of lathes, milling machines, etc. This form tended to reinforce the universalism of machines and workers. Second, machines could be arranged in groups according to the object being machined - object organisation - appropriate in cases where major parts were being machined, each requiring many operations. This form gave the possibility of developing differentiation of operations and machine specialisation. In practice, both forms of organisation tended to coexist at any given enterprise.

With increasing seriality of production it became profitable to extend the process of specialisation and operational differentiation to the point of creating a new organisational form, continuous flow production. The essence of this new form was summarised by Ford himself: "Dividing and subdividing operations, keeping the work in motion - these are the keynotes of production".¹ As applied to machining processes continuous flow organisation involved the breaking down of the work cycle into separate operations and sub-operations, each performed by a separate, more or less specialised machine, the machines being arranged in sequence according to the work flow. The transfer of the workpiece from machine to machine could be effected by hand or mechanical transfer devices. The

1. Ford, H., My life and work, 1928, p. 90.

development of flow organisation further accelerated the process of machine specialisation and worker deskilling.

Machine specialisation and operational differentiation with continuous flow organisation were pushed to the point where contradictions appeared which could only be resolved by reversing the trend of development. Machine specialisation became unprofitable; the differentiation of operations led to an increase in the number of units of machinery, which in turn demanded more space and also increased the time spent on inter-machine transfers. Differentiation of operations tended to heighten the role of inspection work in order to maintain quality standards, while the necessity of transferring the workpiece from machine to machine had a deleterious effect on quality because the workpiece had to be fixed for machining many times. In general, machine differentiation and specialisation met diminishing returns. It is notable that highly differentiated continuous flow organisation has often found its fullest expression under wartime conditions, when it permits the assimilation into engineering production of large numbers of women and young workers normally excluded because of trade union opposition to dilution of the labour force.

These negative tendencies at a certain point promoted a new stage of development of flow production and machine tool technology, characterised by the concentration of operations and the creation of more complex, multi-operation machines designed for the simultaneous or sequential fulfilment of a number of operations on a single workpiece.¹ This intensification of technical processes, frequently associated with a transition to a higher level of automation, overcame many of the problems of the previous stage and permitted a higher level of productivity. The modern transfer line is a characteristic example of this new stage of development of machine tool technology. The concentration of processes freed machine production from the limitations of the old, manufacturing division of labour characteristic of the previous stage of development, and gave rise

1. On the two stages 'differentiation' and 'concentration' see Dem'yanyuk, F., *Bol'shaya sovetskaya entsiklopediya*, 2nd edn., Vol. 34, p. 287; Prokopovich, A., *Tekhnicheskii progress v stankostroenii*, M., 1957, pp. 96-97; Touraine, *op cit*, p. 29 the new stage is here termed the 'phase of recomposition'.

to a reversal of the deskilling tendency. The new machines require highly skilled setters, maintenance workers, repair men, etc., often needing a broad knowledge of electrical, hydraulic and mechanical mechanisms. But with the development of more complex machines the basic machine operator also requires a higher level of skill and understanding of the technical principles of the equipment; skills and experience of a quite different and higher order than those possessed by the universal, craft worker of the first stage of machine development. The physical and mental aspects of the work process divided at the previous stage are now reunited at a higher level.¹

The general outline of the unfolding logic of machine tool technology reveals the overall tendencies and permits an assessment of the degree of 'progressiveness' of different machines at any point in time. However, Soviet decision makers had to choose specific models to meet certain specific demands and their range of choice was quite strictly circumscribed by the actual pattern of development of machine tools in the period immediately preceding the time when the choices were made. Hence it is necessary to consider the concrete facts of machine development and the specific conjuncture at the time of the beginning of rapid industrialisation in 1929-30.

The early development of machine tools will not be considered here except to note that in the USA in the period 1850 to 1900 a whole series of new progressive machine tools was developed largely in response to the demands posed by a succession of new leading engineering branches, notably the armaments industry (especially small arms), sewing machine building, bicycle building and, from the early twentieth century, the automobile industry.² In the decade preceding the 1914-18 War the use of specialised and special purpose machine tools developed strongly in the USA, especially in the large serial and mass branches such as sewing machine building and the motor industry. There was, nevertheless, caution on the part of many managers and complaints in the technical press of the period

1. Kutta, *op cit*, pp. 158-159.

2. See Roe, J.W., *English and American machine tool builders*, New Haven, 1916; Rosenberg, N., "Technological change in the machine tool industry, 1840-1910", *Journal of economic history*, 1963, No. 4, pp. 414-443.

that users frequently showed a preference for general purpose types of lower productivity.¹ The use of special-purpose machines was mainly confined to the textile machinery branch characterised by a high level of product stability and a large volume of output. In Europe the bias towards universal type equipment was much greater, with little use of special-purpose machinery except in such branches as textile machinery, and sewing machine building in particular.

In the immediate pre-War period a development in the United States opened a new stage of machine tool technology - the adoption of the continuous flow principle of organisation at the Ford factory. Flow assembly was first introduced in 1913, and by the end of the year the benefits of flow organisation of machining processes were also being propagated by Ford engineers, who stressed the advantages stemming from the elimination of 'trucking' between operations and the reduced working capital requirements, which were deemed sufficient to justify investing in specialised machines even ^{if} they could not be used to full capacity.²

The First World War had a number of important and lasting consequences for the development of machine tool technology and production organisation in the engineering industry. Two main forces were at work. First, there was the necessity of mass producing military equipment, notably shells, rifles and ammunition and, later, aircraft and aeroengines. These products required very accurate machining for fully interchangeable assembly. Second, with the depletion of the skilled male labour force work processes had to be adapted to permit the entry of large numbers of untrained workers, including many women and youths. These demands led to an intensification of the process of work differentiation and specialisation with the breaking down of processes into their simplest possible elements requiring the minimum of skill. Although many special-purpose machines were employed the main thrust was to simple, standard machines, in particular lathes, drilling and milling machines, often without power feed. These machines

1.E.g."Grinders with all sorts of attachments are being bought for perfectly plain grinding, universal milling machines are used for manufacturing work that is more suited to the Lincoln type of machine and fifty seven varieties of feeds and speeds are provided where seven or even less would be equal to the work in hand. This means a higher investment than necessary and very often a lower (rate of) production than machines just suited to the work" - American Machinist, 1910, Vol.33, Pt.1, p.279.

2.The iron age, 4.12.1913, Vol.92, pp.1276-1277.

could be quickly and cheaply ~~and~~ built, required little adjustment and maintenance, and were very easily operated. This form of production technology and organisation on a flow basis was not restricted to the USA; in Russia similar methods were employed¹, and also in Britain, where the dilution of labour met vigorous trade union opposition.²

A crucial factor permitting the use of simple, standard machines was the rapid expansion of the employment of jigs and fixtures which took place during the War years. This was a major change for the European engineering industry, and also, to a lesser extent, the American. The use of fixtures and special tooling secured interchangeable parts, cheapened production, eliminated fitting and allowed the use of less skilled workers in both machining and assembly.

Technical development of machine tools was slight during the War years: all efforts were devoted to output maximization.³ However, from about 1920 technical advance resumed and the lessons of the War began to be absorbed by both machine users and makers; the subsequent events of the 1920s are of considerable relevance to the problem of machine tool choice in the USSR. The outstanding feature of the decade was the appearance of a new class of machines combining features of both general purpose and specialised equipment. The high productivity of special purpose and specialised machinery in large serial and mass production was acknowledged but its use was often found to be uneconomic because of its lack of flexibility. Special purpose machines, while enjoying a temporary vogue in Britain in the early 1920s⁴, were as a rule not favoured in either the USA or Europe after the War. Ford, often regarded as an advocate of the use of special purpose machinery, was in fact opposed to its use except when justified by the specific nature of certain parts and operations.⁵ Narrowly special machines often had to be scrapped if products changed and had a very low resale price. Furthermore, they often required lengthy and expensive development work, requiring close contact between user and maker - for this reason many special machines were built by the users themselves.⁶ On the other hand, for the larger scale production which developed

1. Rozenfel'd and Klimenko, *op cit*, pp. 125-128.

2. *Engineering*, 14.3.1919, pp. 254-255; Cole, *op cit*.

3. *Engineering*, 14.3.19, p. 255; *Mechanical engineering*, 1930, April, p. 411.

4. See *Machinery*, 13.12.1923, p. 345.

5. Ford, *op cit*, p. 90.

in the 1920s in many branches , often linked with the adoption of flow organisation, the traditional general purpose machine was no longer economic in view of its low productivity and high labour skill demands. Its main spheres of use were jobbing-type engineering and repair work. Thus there was a demand for a new class of machines combining features of both special and general purpose types.

The resolution of the contradiction between the benefits of specialisation and the costs of limited adaptability appeared in the early 1920s in the form of new 'production' machine tools which at the time went under a diversity of names - 'semi-universal', 'semi-special', 'special-production', 'standard special-purpose' and 'simplified standard' machines. References to these new production machines appear in 1924 , when they were defined as , "standard in that (they) can be used for a variety of work of a similar nature, but built for high-production"⁷ These production machines were frequently based on standard general-purpose models, but were simpler in having fewer speeds and feeds, a smaller range of adjustment and easier control, permitting the employment of relatively unskilled labour. These new machines took full advantage of high-speed tools developed in the pre-War period, giving them a level of productivity allowing them to successfully compete with special-purpose equipment.⁸

As this new class of machines developed new features began to emerge. First, the relative simplicity of the machines proved conducive to the extension of standardisation of parts and assemblies. Second, automatic features began to be incorporated , further reducing skill requirements and permitting the multiple manning of machines. A leading machine tool engineer writing in 1928 observed that, " ..through the whole range of types the terms semi-automatic and automatic are repeatedly met. The tendency appears to be to make standard type machines with such automatic features as will enable their control in number s by one operator... This tendency may ultimately solve the problem of purely high-production specialised machines, the general utility of which is questioned on the grounds of insufficient scope in production range".⁹

6. Mechanical engineering, 1930, Nov., p.961; Machinery, 12.4.1928, p.57.

7. Machinery, 18.12.1924, p.353, "Production machine tools".

8. On production machine tools see, *ibid.*, 2.19.1924, p.1; The iron age, 14.4.1927, p.1072;

American machinist, 1929, Vol.71, p.427; Mechanical engineering, 1930, Nov., p.961.

9. American machinist (European edition), 30.6.28, p.246E (A.B.Winter).

The development of production machines was promoted by the extension of large serial and mass production in the engineering industry, notably in the United States. Mass production also promoted an even more radical solution to the problem of securing high-productivity and adaptability: in 1923-25 at the Morris Motors Engine factory in Coventry Herbert Taylor and Frank Woollard pioneered the unit construction machine tool and the transfer line, marking the opening of a new stage in the development of machine tool technology.¹ The first transfer machines were not entirely successful, but they did incorporate many standard units. In subsequent years Taylor became a vigorous advocate of the 'unit construction' principle²; all machine tools, he believed, could be built from standard machine units reduced to the simplest possible elements and operated by push button controls, with operations linked by automatic transfer and timing devices. The use of interchangeable units would, he believed, permit the very rapid construction and reconstruction of highly specialised equipment.³ Early in 1929 Taylor promoted his idea of a 'unit continuous system of manufacture' in the USA, finding a more sympathetic response than in Britain, where his ideas had met with some scepticism. But as in Britain some specialists raised doubts as to whether the new unit construction machines were flexible enough. The desire for flexibility was now an overriding consideration as the influential general manager of the Jones and Lamson Machine Co., Ralph E. Flanders stressed: "An earlier tendency in this country towards highly-specialised machines received a severe check when it came to be realised that design changes were not to be occasional and minor, but were to be regular and radical instead. This has led production managers of most automobile shops to a decision in favour of standard tools designed for the application of special equipment (i.e. fixtures and tools - JC) which transforms them into special machines for a given part, but permits them to be changed over for other work at not too great a cost".⁴ Nevertheless, the first elements of unit construction machine tool building began to appear in practice in 1928-29, notably drilling machines with unit heads.⁵ This development was greatly facilitated by the appearance of reliable and compact individual

1. See Institution of Automobile Engineers, Proceedings, 1924-25, pp. 429-438; Woollard, F., Principles of mass and flow production, London, 1954, pp. 26-30.

2. This term was used by Taylor - Machinery, 1.11.28, pp. 137-141.

3. Ibid.

electric motors and hydraulic units. In the United States, certainly, the principle of unit construction achieved a high degree of acceptance: one review of technical developments in 1929 singled it out as the most important new innovation in the machine tool industry⁶. Thus on the eve of the crisis and at the time when Soviet industrialisation was gathering pace a radical new principle appeared, necessitating a major reevaluation of traditional views on the choice of machine tools for certain types of quantity production.

The tendencies towards the use of production machines and unit construction found their fullest expression in the USA. In Europe both tendencies were present but to a much less marked degree: reliance on the traditional general-purpose machine tools was much greater. However, there were notable changes in engineering production technology in Western Europe in the 1920s, with a definite tendency to convergence with American practice. This fact must be considered in view of the currency, particularly in some Soviet literature of the late 1920s and early 1930s, of two stereotypes: the 'American' path of mass production ('Fordizma') and the 'European' path of smaller scale, 'universal' production. The intensification of the tendency towards the differentiation of work processes into ever smaller elements and the associated development of more specialised machine tools was closely linked during the 1920s with the penetration of continuous flow organisation into a widening range of branches of the engineering industry in both the USA and Europe. In Europe, notably in Germany but also, to a lesser extent, in Britain and France, flow methods formed one of the central components of the rationalisation movement. This movement represented an attempt to introduce the benefits of American large scale production into a traditional economic structure characterised by a smaller scale of markets and greater product diversity. Rationalisation, embracing a reduction in the number of active enterprises, increased standardisation and a reduction in product ranges created conditions in which flow organisation could be adopted.

In Germany high priority was granted to reaping the benefits of flow production. In order to minimise investment demands, emphasis was placed on non-mechanised

⁴ American machinist, 9.2.1929, pp.62-63 Emphasis added.

⁵ Machinery, 13.12.1928, p.351.

⁶ Ibid., 12.12.1929, p.336.

flow work attained by a reorganisation of the machines into sequence according to the work flow, but without the use of transport devices.¹ By the end of the decade flow organisation in machining had been introduced in the motor industry, the electrical engineering industry (Bosch, GEC and Siemens)² and even the machine tool industry (Ludwig Loewe)³. Although restricted to a limited number of progressive firms these organisational changes began to exert an influence on the German machine tool industry; in 1928 it was reported that, "The latest development of the German industries is characterised by an increasing use of quantity production methods and, in part, by a gradual transition to the system of continuous line production", and this was leading to.. "the replacement of the standard universal machine tools by special tools which have their speed and feed rates adequate to the proper special purpose".⁴ This trend continued in 1929, but it was evident that the general engineering user was still the main sector of the market; as a review of the year's developments noted, "In accordance with the requirements of European production schedules, machine tools of the universal type, which can be readily adjusted to suit a variety of components, have shown a marked predominance. At the same time there has been a definite increase in the demand for single-purpose machines simplified as far as possible. Further, it may be noted that in some instances machines have been so designed that they may be readily arranged for continuous line production".⁵

The pressure on firms of intensified competition and more frequent product changes were also being felt in the USA before the onset of the crisis. The turn towards production machines has been noted, but in the late 'twenties there were even advocates of the use of standard general purpose machines in order to gain greater flexibility even in quantity production.⁶ The lessons of the Ford experience in changing from the Model 'T' to the 'A' in 1927 after a run of over twenty years seem to have been quickly appreciated. The new Ford factory at River Rouge had more adaptable machine tools than those previously employed and this new development

1. Rubinshtein, M., *Kapitalisticheskaya ratsionalizatsiya*, M., 1930, pp. 54-55.

2. *ibid.*, p. 62; See also Brady, R., *The rationalisation movement in German industry*, U. of California, 1933, pp. 156-161.

3. Ludwig Loewe and Co., *Aktiengesellschaft Berlin, 1869-1929*, Berlin, 1930, pp. 94-99.

4. *Machinery*, 13.12.1928, p. 351.

5. *ibid.*, 12.12.1929, p. 360.

6. *American machinist*, 9.2.1928, p. 255.

was welcomed in Britain: it was noted that Ford's new equipment was "very much more flexible, and could be used in this country without any alteration at all".¹

One further very important aspect of machine tool development in the industrially advanced capitalist countries at this time must be considered for a full appreciation of the nature of the changes which occurred - the question of the skills of workers operating and servicing the machines. Dramatic changes took place during the War and the 1920s in both the USA and Western Europe; changes made possible by the higher level of specialisation and automation of machine tools and the new forms of production organisation. The consequence can be briefly summarised²: a mass deskilling of the labour force of the engineering industry. Some general statistics reveal the magnitude of this process. In 1930 the structure of the American engineering industry labour force was approximately, skilled workers 25 per cent, semi-skilled 55 per cent and unskilled 20 per cent.³ In Germany the proportion of skilled workers in the engineering industry fell from 68 per cent in 1925 to 48 per cent in 1928⁴; while in Britain the proportion of skilled workers fell from 60 per cent in 1913, to 50 per cent in 1921 and 40 per cent in 1926, with a corresponding increase in the share of semi-skilled workers from 20 to 30 and 45 per cent respectively.⁵ This deskilling was accompanied by an increase in the employment of women and young workers in the engineering industry.

Summarising the development of machine tool technology in the 1920s, the main features were; first, an increasing reliance on 'production' machines as opposed to the universal on the one hand, and special-purpose machine on the other; second, the appearance of a new method of building high-productivity specialised machine tools; third, the spread of continuous flow production organisation to Europe with signs of some convergence in American and European machine tool technology. These developments did not spell the death of the general-purpose machine tool: in many branches it remained the basic equipment and during the

1. Institution of Automobile Engineers, Proceedings, 1930-1931, p.193.

2. This question is also considered in chapter 11.

3. Recent social trends in the United States, NBER, New York, 1933, p.808.

4. Rozman, M., Kapitalisticheskaya ratsionalizatsiya i rabochii klass, M., 1940, p.223.

5. Balfour report, Survey of industries, Part IV, London, 1928, p.152.

period it underwent technical improvement as design features originally pioneered on special and specialised machines gradually found wider application.

The crisis and machine tool technology

The influence of the crisis on technical progress in machine tool building has been considered elsewhere ; in this section only its impact on the degree of specialisation and automation of machines will be analysed. The crisis posed certain economic demands on machine tool technology. The volume of output was generally reduced, product differentiation tended to rise, the level of production specialisation fell and the drive for profitable operation in the circumstances of a greatly restricted market posed the need for an intensification of production processes.¹ The two main demands were therefore productivity and flexibility. The primary tendency was for the despecialisation and universalisation of machine tools , while at the same time the productivity of general-purpose machines was further enhanced by the adoption of technical developments accumulated in the previous period, notably the new super-hard alloy tools. The need for cost reduction and intensification of production also led to a deskilling of general-purpose machines by means of simplification and lightening of control, achieved by the use of electric devices, pneumatic chucks, automatic gauging devices, etc. This 'revolution' in machine tool design led to a resurgence in the use of the standard general-purpose machines , their employment being extended to serial production previously the preserve of more specialised production equipment.

By 1933 this new trend towards the use of general-purpose machines was being acknowledged as a significant development by engineering industry specialists; a British observer noted that:

"In boom conditions attention is centred on getting output, and much high production plant is installed regardless of expense, the only factor of any account being , apparently, that of increasing production. Now under the present conditions of business, production processes must not only be made to conform to smaller schedules; the manufacturing range must also be made

1. The impact of the crisis on capitalist production methods is discussed by Rozman, op cit; Rozman, M., Problemy ekonomiki, 1935, No. 4 ; Werkstattstechnik, 1932, No. 5; Leikin, ZaInd., 7.11.1933.

wider in order to maintain the amount of work in the shops. This change has caused the production engineer to modify considerably his estimate of the relative value of different types of plant. No longer is the high production, multi-spindle, multi-station machine able to justify itself to the same extent, so that thoughts are necessarily turned to the more standard types of machines. But apart from considerations of market conditions, developments of the past few years in the machine tool industry are sufficient to call for a change of outlook on the relative commercial value of the specialised high-production machine and the standard tool. In the early days of mass production the standard tool possessed only features resulting from normal development, whereas the high-production machine was relatively much more advanced due to the impetus designers received under the pressure of production needs. The general employment of high-production plant greatly increased knowledge of machine tools generally, and this knowledge was utilised to develop the standard machine, until at the present time, when all factors are taken into consideration, it is often found that this type of plant is the more profitable".¹

These new general purpose machines were suitable both for work under the conditions of the crisis and when markets revived somewhat in the mid-1930s.²

While the crisis led to an extension of the scope of general-purpose machines, technical development in the field of high-productivity types did not altogether cease and in fact gathered pace as the economic revival led to reequipping of the large serial and mass production branches, notably those producing motor vehicles and consumer durables. The need to allow for rapid product changes was now a dominant consideration in choosing equipment; versatility was obtained by employing unit-construction machines, the development of which evolved with great rapidity in the 1930s. Typical of the new trend was the range of 'Powerpack' units developed by Ingersoll, providing the basis for many high-productivity, specialised but adaptable machining installations, including transfer lines for machining such components as cylinder blocks and rear axle units.

As the large-scale production branches revived interest in high-productivity specialised and automated machines of more traditional types once again developed: the majority of new American models of 1935 were of this type.³ The significant

1. The machinist, 4.3.1933, p.65E, Editorial.; see also Machinery, 30.11.1933, p.248.

2. The machinist, 13.6.1936, p.313E.

3. Machinery, 12.12.1935, p.328.

feature of these new specialised machines, however, was their greater flexibility compared with earlier examples, and this flexibility not only made them suitable for meeting American demands of frequent product changes, but also rendered them suitable for use in European conditions.¹ One of the interesting features of the West European engineering industries during the 1930s was the production and use of American type specialised machine tools. A number of machine tool firms began to build American models on a regular basis, and some American firms established their own production facilities in Europe, e.g. Cincinnati. Thus by the mid-1930s in Britain the Churchill company was building Cone and Fay automatics, BSA was making Gridley autos., and American-type high productivity gear-cutting machines were being built by a number of firms.² It is possible that this trend was influenced by the Soviet practice of using high-productivity specialised equipment.

From the mid-1930s and throughout the rest of the decade the demands of rearmament exerted a very strong influence on machine tool technology. This complex question is discussed separately in Appendix 5. In general military demands served to accentuate tendencies of development already evident, including the need to create high-productivity, specialised machines of great flexibility, and also the trend towards deskilling machines by the wider adoption of a range of automatic features.

This review of the development of machine tool technology reveals above all the complexity and historical relativity of the solution to the problem of machine choice. The categories 'general-purpose', 'specialised' and 'special' machine tool are not static in content but highly dynamic, changing in response to economic conditions and technical possibilities. Furthermore, the basic types of machine - lathe, drilling machine, automatic, etc. - are not by their nature of a certain degree of universality or specialisation: there is a range of possibilities within each type group. Analysis of the development of machine tool technology in the inter-War years also indicates the conditional nature of the distinction between 'American' and 'European' forms of production organisation and machine tool use and the need to avoid an oversimplified counterposing of one to the other.

1. The iron age, 20.6.1935, p.83.

2. Machinery, 3.10.1935, pp.26-30; also SiI, 1935, No.2, p.3.

Certainly in the early 'twenties the European engineering industries were characterised by a reliance on universal machine tools and non-flow forms of organisation, with a much lower average level of seriality of production than in the USA. But in the course of the decade, especially in Germany, under the impact of the rationalisation movement, a definite convergence began to place which by the end of the decade was exerting an influence on machine design in the direction of greater specialisation. This trend continued in the 1930s when American-type specialised and automated machines found much more general application, partly because the machines themselves had been made more adaptable to meet the circumstances of the crisis. It is notable that one of the most advanced, high-productivity machining systems of the decade was installed not by an American firm, but by the Citroen company in France.¹ Furthermore, in the 1930s the German machine tool industry developed a new range of high-productivity, multi-tool lathes and turret lathes for use by workers of relatively low skills. Thus at the time of the First Five-year Plan there was definitely a difference between the average practice of America and Europe, but the latest, most progressive production and technical practice of Western Europe was undoubtedly coming into line with that of the United States.

The Evolution of Soviet Policy

This section is devoted to a review of the Soviet discussion of the problem of the choice of machine tool technology, both from the point of view of the types of machines to be built by the domestic machine tool industry, and the types to be installed in the Soviet economy. This discussion was carried on in industrial and technical press (and occasionally in the pages of Pravda and Izvestiya), at machine tool industry conferences and within VSNKh and NKTP. It was usually linked with broader discussion of the path of development of the machine tool industry, considered separately in Chapter Four.

1. A multi-station unit construction production line built by the American firm, Ingersoll, for the machining of cylinder blocks. See The Machinist, Vol. 73, 1934, pp 629-636.

Four main periods can be identified, although it is difficult to identify clear boundaries marking the transition to new stages of discussion; the first period ran from about 1926 to about the summer of 1929; the second from mid-1929 to mid-1933; the third from mid-1933 to about the end of 1934; and the final period from the beginning of 1935 to the outbreak of War. These periods are now considered.

1926 - Mid-1929

During the three years prior to the foundation of Stankotrest the output of the factories building machine tools consisted entirely of relatively simple and primitive universal models of lathes, drilling machines and planing and shaping machines. Virtually no grinding or milling machines were built, and no turret lathes, automatics, gear-cutting machines or special machine tools. The sole representative of the industry to write regularly on policy questions at this time, M. Orentlikher, held a consistent view on the question of technological choice which was first stated in 1926. Orentlikher was critical of the universal machine tool on the grounds that many of its features were rarely used and that the range of feeds and speeds was excessive for normal purposes. On the other hand, special machine tools employed abroad in mass production were inflexible. His policy conclusion was that, given the predominance of 'semi-serial' or serial production and the fact that mass production was exceptional, attention should be focused on 'simple, standard machine tools with a limited circle of work'. These machines were to be supplied with appropriate fixtures to raise their productivity and give the possibility of expanding their range of work.¹ Thus, Orentlikher was effectively calling for the adoption of the production machine tools, then beginning to find wide application in foreign industry. He also added that if special machines were to be built they should be based on standardised parts and assemblies common to more universal machines; such a compromise would give greater flexibility.²

Orentlikher restated his views in January 1929. Production-type machines were again favoured, and on this occasion he also observed that, for the years of

1. Vestnik izhenerov, 1927, No. 12, p. 542.
2. Sistema i organizatsiya, 1926, No. 4, p. 12.

the First Five-year Plan , ".it is necessary for us to refrain from producing automatics, semi-automatics and a number of specialised machine tools and also little-used machines - multi-spindle drilling machines, keyway and two-spindle milling machines, thread millers, gear-cutting machines, etc.".¹

Al'perovich, at this time head of Orgametall, also had definite views on the appropriateness of different types of machine to Soviet conditions - in this case American or German technology. American machine tools were, he observed, on average 20-30 per cent more expensive than European equivalents, but were more productive and required less skilled labour for their operation. They were generally sold tooled-up for the making of a specific part at a predetermined rate of output, and permitted the adoption of superior forms of production organisation. Al'perovich's policy conclusion was that Soviet industry should order from the American industry only the most specialised machines intended for fulfilling specific production processes, otherwise the additional cost was "completely unjustified".² The main alternative was for Soviet industry to purchase from Germany, a policy which had, he believed, certain definite advantages stemming from geography, stable foreign relations, the good knowledge of German practice possessed by many Soviet engineers, favourable credit conditions, the German willingness to provide technical services, and finally, the suitability of German machine tools to Soviet conditions and demands.³

German machine tools were, Al'perovich acknowledged, generally of the universal type. They were frequently copies of the best American models (although often out of date), they were cheap, but sometimes of poor quality. But while recognising the advantages of buying German machines he was critical of German practice of machine tool choice which, he believed, gave rise to a bias towards universal, low productivity types. There was a general tendency, Al'perovich observed, for the power-to-weight ratio of machine tools to rise and also for the value per unit machine to steadily increase. Further, it was "quite obvious" that the more expensive a kilogramme of machine tool, the cheaper would be the cost of each

1. Torg.-prom.gaz., 30.1.1929.

2. ibid., 17.3.1928.

3. Novosti stankostroeniya v Germanii, M., 1927, p.5.

kilogramme of metal cut by it, "even taking account of the amortisation of its greater initial cost".¹ In fact, he added, "In those cases where such productive machines have been secured work of an appropriate character and volume and also suitable tools, a dearer machine will always be more profitable to use than a cheaper one". But German industry did not buy such modern productive machines. According to Al'perovich, when asked why this was so German managers answered that, "We are not rich enough to pay 5.5 marks per kilo of machine tool". This he characterised as a "primitive commercial" explanation, rather than a proper "engineering - cost calculation" approach. Soviet industry, he added, suffered from the opposite "deviation": "Very often we take little interest in the cost of the machine tool, so long as it is the 'last word of technology' and corresponds to 'the latest fashion'".² Thus while acknowledging the need to employ more specialised and productive machines when conditions permitted (these machines were to be purchased from the USA), Al'perovich saw the German machine tool industry as the primary supplier even though its products were usually of a universal type.

Minimisation of foreign exchange costs was clearly a major factor in Al'perovich's argument for reliance on the German market, and this consideration was clearly influential in other proposals of the period. M. Sorokin argued for the acquisition of foreign second hand machines, in particular from the USA, where even quite new machines were discarded because of rapid obsolescence;³ in the following year this demand was echoed by Al'perovich.⁴ In February 1929 another specialist, I. Rybal'skii-Butevich proposed measures for raising the productivity of the existing stock of old machines by repairs and modernisation, leaving the machine tool factories to concentrate on more complex products.⁵

The First Five-year Plan itself, adopted in May 1929, posed before the machine tool industry the task of meeting the demand for the most widely used (*khodovoi*) types of machine tools. But the building of 'special machine tools' (clearly in

1. *ibid.*, p. 6.

2. *ibid.*

3. *Torg.-prom.gaz.*, 7.14.1927.

4. *ibid.*, 17.3.1928.

5. *ibid.*, 2.2.1929.

this case both specialised and special-purpose types) was to be restricted to a scale sufficient for gathering experience in preparation for their production in the following five-year period.¹ The Plan did not lay down which types of machine tools were to be installed at the new and reconstructed enterprises of the engineering industry. Thus, in this first period, the main emphasis was on the general-purpose or production type machine tool.

Mid-1929 - Mid-1933

In policy discussion during the first period the main stress was on machine tools of a relatively unspecialised type suited to the demands of small and medium serial production, but in 1929, especially after the adoption of the Plan, this emphasis began to be challenged. The NK RKI survey of machine tool building published in May 1929 considered that the lathes built by Soviet factories were excessively universal and complex, and attention was drawn to the neglect of high-productivity machines (turret lathes, automatics, semi-autos., etc.) despite the 'considerable demand' for them.² In his report on the conclusions to be drawn from the survey M.Kaganovich stated that with regard to the structure of types built Soviet machine tool building had to emulate the American industry. Concern over the structure of machine tool production and installations probably mounted following the struggle in Gipromez in February 1929 for the adoption of mass production technology at the new Stalingrad tractor factory.³ American mass production engineering technology was also championed by Sorokin⁴ and M.Gurevich.⁵ In December 1929 Gurevich sharply attacked the orientation of the domestic machine tool industry to the demands of the 'serednyak' user: large-scale users were able to acquire foreign equipment, the remainder were forced to accept the inadequate Soviet machines. The increasing emphasis on mass production required, he concluded, the domestic production of modern machines orientated to the advanced, large-scale users.⁶ Thus in the course of 1929 the policy outlined for the Five-year Plan period began to be challenged and this criticism gathered strength in the following year.

1. Pyatiletnii plan narodno-khozyaistvennogo stroitel'stva SSSR, 3rd.edn., M., 1930, Vol.2, pt.1, pp.156-157.

2. Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, op cit, p.158.

3. See Ilyin, Y. and Galin, B., Those who built Stalingrad, N.Y., 1934, pp.32-38.

4. Torg.prom.gaz., 12.1.1929.

In this second period a number of distinct schools of thought can be identified. First there was a tendency which favoured the use and production of universal machine tools. Second, there was a broad tendency which favoured specialised machines, and within it two main sub-tendencies - one favouring an 'American' solution, the other the use of simple, specialised machines. Third, there was a radical tendency which offered a critique of all existing machine tool technology. Finally, there was the position of Al'perovich, the head of the specialised machinetool industry; a position which changed in the course of the period and cannot be directly assimilated to any of the main tendencies, but also cannot be considered a distinct school of thought. The arguments of the representatives of these tendencies will now be reviewed.

For universal machine tools

The views of those favouring universal machine tools must be inferred because their position was not stated in discussions in the press. However, there is no doubt that this tendency was dominant during the period prior to the First Five-year Plan and extremely influential during it. This school of thought, which took traditional European practice as its model, had adherents both in the machine tool industry itself and in user branches of industry and other sectors of the economy. In the machine tool industry it is evident that many concerned with production, as opposed to design, favoured the building of a limited range of general-purpose machine in large quantities. On the user side there was a very substantial demand for universal types on the part of repair shops, FZU schools and small and medium sized engineering shops and factories. Even in some of the larger factories there was a bias towards universal equipment, as will be shown below. The use of universal machine tools was the traditional practice of the Russian engineering industry and was clearly regarded by many practical workers as the well-tried practice of the leading West European countries and therefore worthy of emulation. Furthermore, supply possibilities must have reinforced this attitude: German universal type machine tools were more readily available and cheaper than American specialised models, while the machine tools built by Soviet factories before and during the First Five-year Plan period were all of the

general-purpose type. There were good reasons for this bias to universalism from both producers' and users' standpoints and the persistence and vigour of its critics testifies to its strength.

For specialised machine tools

The second school of thought is that which began to assert itself in 1929. A number of different positions within this tendency can be distinguished, the most influential being the 'American' path advocated most strongly by M.Kaganovich of NKRKI (later NKTP) and M.Sorokin of Avtotrest (later Stankoimport). One of the earliest public statements of this tendency was that of Kaganovich at the Sixteenth Party Congress in July 1930. He began by comparing the structure of types to be built by the end of the Plan period and the structure of the American machine tool stock of 1930. In the USA automatics accounted for up to 10 per cent of the stock in mass production enterprises, but they did not figure at all in plans for the Soviet machine tool industry. Lathes, however, accounted for 20 per cent of the American stock, but were to account for almost fifty per cent of Soviet output. For milling machines the proportions were 10 and 5 per cent respectively. American machines were certainly more expensive than German, he admitted, but their productivity was such that they gave a lower cost per unit of output: the higher the quality of the machines, the less the number needed and the higher the productivity. Furthermore, American machines were tooled-up for specific processes, whereas Soviet machines were built for anonymous buyers with harmful consequences for productivity.¹ Shortly after the Congress Kaganovich restated his position and his policy conclusions for the Soviet machine tool industry. American machine tools, he wrote, had been developed under the influence of the mass production motor industry, which demanded maximum productivity and great accuracy for interchangeable parts. They tended to be more rigid than German machines and to have relatively simple controls. The lesson for Soviet machine tool building was that it had to use all the latest achievements of the American industry. Account had to be taken of individual cases and requirements, but, "American types of machine tools, the designs of which are orientated

¹. XVI s"ezd VKP(b), sten.otchet, op cit, p.520.

primarily to mass production, for high productivity and for simplicity of use and control should be better suited to our conditions than German machines which up till now have been orientated primarily to small-serial and large-serial production".¹ But while promoting the case for building American-type high-productivity machines Kaganovich also called for a limitation of the number of types and sizes built and the introduction of flow production methods into machine tool building. These policies were not compatible with the rapid assimilation of specialised types in the circumstances of 1930 : his position was thus to some extent contradictory.

"Mark Lavrent'evich Sorokin was known as the American. Such was his nickname. He knew about this and even seemed to be proud of it";² this was the comment of a recent work which, in part, discussed the role of Sorokin as head of Avtotrest. Sorokin was one of the most consistent and vigorous advocates of American technology and industrial organisation during the first two Five-year Plan periods. From 1931 he frequently expounded his views on policy for the machine tool industry and presented a radical alternative to the practice of the branch. "The task of the machine tool industry", he wrote, "is to help industry outlive its archaic bias towards the methods of the fitter's workshop as rapidly as possible".³ The bias towards universal machines shown by many enterprises was, he believed, an element of this backward technical culture and closely linked with the low level of specialisation of production in the engineering industry. With the wide-scale adoption of the principles of specialisation and cooperation the universal machine would have an "extremely modest place". Under capitalism there were major obstacles to the replacement of universal machine tools in the shape of competition, limits on the specialisation of production, the existence of small enterprises, excessive product differentiation, etc.. The Soviet, socialist, planned economy alone offered the possibility of fully reconstructing industry on the

1. *Za Ind.*, 24.7.30.

2. Dobrovolskii, E., *Daesh avtomobil'!*, M., 1971, p. 43. For an early example of Sorokin's passionate Americanism, see his booklet *Ob Amerikanskikh tempakh*, M., 1930. He was an economist by education and had commercial rather than industrial experience before his appointment as chairman of Avtotrest in 1928. Two recent works provide a negative assessment of his abilities in this post (*ibid.*, and *Direktor - I.A. Likhachev*, M., 1971, pp. 13-15). A more positive assessment of his technical and organisational abilities as director of the Tula arms factory in the mid-1930s is provided in *Istoriya Tul'skogo oruzheynogo zavoda, 1712-1972*, M., 1973, p. 226.

3. *Sotsialisticheskaya rekonstruktsiya i nauka*, 1931, vyp. 2-3, p. 122.

basis of specialisation and concentration of production, although Sorokin was careful to note that such a reconstruction could not be achieved all at once. Starting from the assumption that the Soviet engineering industry would be so reconstructed he proceeded to outline what he considered to be the appropriate choice of machine tool technology.

The startingpoint of most of Sorokin's contributions was a comparison of the structure of the machine tool stock of the USA with the planned and actual structure of Soviet machine tool output. Such a comparison revealed the Soviet industry's neglect of high-productivity types. In Sorokin's view the leading machine tool using branches by 1931 were the auto-tractor industry, the aircraft industry and the building of agricultural machinery, i.e. all branches characterised by large-serial or mass production, with the auto-tractor branch to the fore with respect to machine tool technology. Therefore, he believed, the domestic machine tool industry had to rapidly assimilate the high-productivity types needed by this and other leading sectors. Universal machines would of course still be needed, but in relatively small quantity, and Sorokin believed that the requirements of the repair sector could best be met by building combined machines, i.e. highly universal machines combining lathes, milling and drilling machines in a single unit.¹

The expediency of installing high-productivity automatics and semi-autos was argued by Sorokin with examples drawn from the motor industry, which suggested that not only were there substantial savings to be derived from reduced labour costs, but also savings stemming from lower fixed and variable costs. In some cases, he demonstrated, a single high-productivity machine had a lower initial capital cost than several universal machines it replaced.² But there were also significant capital savings to be obtained from reduced floor space requirements: one square metre of factory production shop area had a cost of 115-120 rubles, so that if four machines were replaced by one of equivalent output per unit time a saving of up to 4,000 rubles could be achieved. Furthermore, the higher rate of output led to acceleration of the circulation of working capital with consequent

1. *ZaInd.*, 7.2.1931; *Sotsialisticheskaya rekonstruktsiya i nauka*, 1931, Vyp. 1, pp. 112-114.

2. See below, p. 262.

savings. The conclusion for Sorokin was clear - the building of automatic, multi-spindle and other high-productivity machines had to become the leading direction of machine tool building.

While promoting the building and use of relatively complex, high-productivity machine tools, Sorokin was also concerned with the need to supply industry with more specialised machines. Mass-flow production with differentiation of the production process into a large number of simple operations offered the possibility of using many simple machine tools, obtained by simplifying standard universal models, e.g. by reducing the number of speeds and feeds to a minimum, or by removing the lead screw from lathes. Such machines were easier to use and repair and were of much lower initial cost than the usual standard machines. Sorokin favoured the building of the most common general-purpose types on the foundation of 'basic models' incorporating many standard parts and assemblies allowing the creation of ranges of modified and simplified machines for specific purposes.¹ Finally, Sorokin favoured the building of 'flexible' special machine tools by the unit-construction principle. The building of machines from standard sub-assemblies opened the way to the creation of narrowly-special machines of very high productivity combining a number of operations, and also gave the possibility of making the standard assemblies on a large-serial or even mass basis.² Despite his enthusiasm for American technology, Sorokin cautioned against an 'extraordinary infatuation' with American types of machine tools - they were generally the best, but those of other countries, in particular Germany, were worthy of attention.³

The 'American' school had many other representatives, but their positions were similar to those of Kaganovich and Sorokin. The main thrust of this tendency was towards the building and use of the high-productivity types used in American industry - automatics, semi-autos, multi-spindle drilling machines, centreless grinders, special milling machines, etc. These machines were relatively complex

1. Sotsialisticheskaya rekonstruktsiya i nauka, 1931, Vyp. 2-3, p. 115.

2. ibid., pp. 115-127; ZaInd., 12.2.1931.

3. ZaInd., 12.2.1931.

and difficult to build, and sometimes required quite highly skilled labour for their operation and servicing. They also tended to have a high initial cost. It is difficulties such as these which gave rise to a modified solution to the problem of machine tool technology based on specialised equipment. One of the most coherent expositions of the case for an alternative approach was that of a prominent machine tool engineer and designer, A. Pankin, presented in the summer of 1930¹. Pankin's initial premise was the same as that of Sorokin - Soviet industry had to make a decisive transition from serial to mass production. Under capitalism, especially in the USA, the relative cheapness of machine tools made it possible to employ general-purpose type machines in serial and even mass production, but, Pankin stressed, this was not a rational practice. Mass production permitted the employment of machines with a very limited range of feeds and speeds, without lead screws, with very few accessories, etc.. In Pankin's view the correct path for Soviet industry was that of building special machines of a simple nature for a whole series of characteristic components.

Pankin saw very great benefits from the use of such simple, special machines as opposed to the more complex conventional high-productivity types. The simple machines were, he observed, intimately connected with a certain system of production organisation which he believed to be best suited to Soviet conditions, i.e. the differentiation of the production process into the smallest possible simple elements, as opposed to the practice of concentrating operations permitting the use of multi-tool and multi-station machines of high-productivity. The main advantage of the former approach was that workers of very low skills could be employed to operate the simple, specialised machines, whereas the second approach (the 'American' path) required skilled workers to set and maintain the machines and make appropriate tooling. The simple machines would be cheap, easily and quickly built, would give substantial foreign exchange savings and simplify labour training. Pankin did not rule out the use of more complex, high-productivity equipment; the relative expediency of one or other path depended primarily on the seriality of production, and in practice a mixed approach would often be adopted. Thus Pankin presented an alternative to both the 'European' and 'American'

1, SiI, 1930, No. 1-2, pp. 2-5.

tendencies, his position being closer to that of the practice of the First World War, when many simple, special machines were used in mass production permitting the employment of inexperienced, low skilled workers.

In the autumn of 1932 a more extreme variant of this approach was put forward by A.Zernov of Stankoob"edinenie. "The future of socialist industry," he wrote, "undoubtedly belongs to narrowly-specialised giant factories working to a continuous production flow. Each machine tool in such a flow fulfils a limited and unchanging function. This permits the designing of it as narrowly special, and the large quantity of similar narrowly-special machine tools allows them to be produced on a serial or, frequently, a large-serial basis".¹ Such a high degree of specialisation was, Zernov believed, unacceptable for capitalist industry and therefore Soviet industry would have to create its own independent designs. This could best be achieved by building machines from standardised parts and mechanisms on a unit-construction basis. One of the main advantages of this approach, in Zernov's view, was that it would greatly reduce the skill required by machine operators. But even narrowly-special machines required some skill for their operation; this requirement could be eliminated entirely, he believed, by automating the machines, with the eventual possibility of creating a unified automatic "production organism".

One factor missing from both Pankin's and Zernov's arguments was the need to allow for product design changes: both abstract from the demands of technical progress. Zernov's call for unit-construction was aimed not at securing rapid reconstruction in the event of design changes, but at achieving rapid initial construction. It was the question of flexibility which formed the focus of the arguments of the third main tendency on the problem of machine tool choice.

'For a revolution in machine building!'

At the First Conference of Industrial Managers in early 1931 A.K.Gastev, head of the Central Institute of Labour, at a session of the section on machine building, declared that, "Those machine tools which we have now and which we import from abroad lag so far behind present day technical thought that their

¹ Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No.9-10, p.85.

only place is in a museum".¹ Gastev and his team at TsIT, notably N. Bakhrakh, were alone in the Soviet Union of the First Five-year Plan in presenting a radical critique of all existing machine tool design and production practice and in offering an alternative which they believed to be the only rational path for the socialist, planned economy. Gastev's views on 'technical reconstruction' of machine building were first stated in general terms in the spring of 1930², but did not receive public attention until May 1931 when almost a whole page of ZaIndustrializatsiyu was devoted to the work of TsIT under the heading 'For a revolution in machine building'. The work of TsIT is considered in detail elsewhere;³ here only the main elements of Gastev's alternative policy will be considered.

The TsIT workers rejected the traditional machine tool classification into 'universal' and 'special' machines, and even the usual type classification - lathes, milling, drilling machines, etc. The basis for classification had to be functional, in so far as all machines are composed of a small number of common functional elements, e.g. elements of rotation, or backward and forward motion. The new machine tool building was to be based on standard functional elements which could be very rapidly assembled to make machines to meet the demands of specific production processes, i.e. each machine would be narrowly-special, but at the same time highly adaptable. Gastev considered that it would be possible to make the standard functional units at specialised enterprises on a large-serial or mass basis, while engineering factories would be able to easily assemble their own machine tools. Repair and maintenance work would be transformed - faulty units would simply be replaced.⁴

The radical proposals of Gastev and his team found immediate support in certain quarters. His ideas were propagated with great enthusiasm by a prominent engineer, E. Perel'man⁵, while at a meeting in the Communist Academy in 1931 an economist, Krasovskii, likened Gastev's analysis of machine functions to Mendeleev's table of elements.⁶ But it is doubtful whether Gastev regarded his work as offering

1. Pervaya vsesoyuznaya konferentsiya..., op cit, p.222.

2. See Kak nado rabotat, M., 1972, pp.443-449.

3. See Appendix 7.

4. ZaInd., 26.5.1931; 11.3.1932; Bakhrakh, N., et al., Standartizatsiya mashin, M., 1933.

an immediate practical solution for Soviet industry; its importance lay in its future potential. The research work of TsIT on technical reconstruction was supported by a Party Central Committee decree of 6th May 1931⁷, and had the backing of M.Kaganovich within NKTP.⁸

'Stankoob"edinenie" and the choice of machine tool technology

Finally in this review of the main schools of thought on the question of the choice of machine tool technology we consider the position of the specialised machine tool industry and its head, Al'perovich. Unlike the other participants in the debate Al'perovich had direct responsibility for the realisation of technical policy in the industry and for this reason his ideas are of particular interest and importance.

On a number of occasions during 1930 Al'perovich acknowledged that the types of machine tools then being built were too old and simple to meet the demands posed by industrialisation.⁹ In March 1931 he responded to Sorokin's criticisms of the branch's policies and outlined his views on technical choice. The path of development of Soviet machine tool building could not be determined simply by analysing the development of world machine tool technology, he stressed; account had to be taken of the specific features of the Soviet situation and the tasks posed by the current and future Five-year Plans. There were a number of factors which combined in the short run to present an unusually large demand for universal-type machines. Large numbers of simple lathes, shaping machines, universal milling machines, etc. were required by factory FZU schools and technicums, the new, giant factories required very large toolrooms in order to make the tools, jigs and fixtures needed in starting up production; and the new collective and state farms, and the MTS, required many universal machines for their repair shops. Therefore, Al'perovich concluded, simple universal machines were needed in much larger quantities than envisaged by Sorokin. However, he did not deny the importance

5. Perel'man's enthusiastic endorsement of Gastev's work is worth quoting: "We have (here) without doubt, a manifestation of enquiring socialist thought, a striving to free technology from the captivity of isolated individualism to which it has been condemned by capitalism with its individualistic bias. The practical realisation of these new tendencies will open hitherto undreamed of horizons, an epoch, as it were, of socialised machine building technology giving the possibility of building any combination for any form of mechanical work from a certain number of groups and ranges of parts..

of rapidly organising the production of high-productivity machines needed by the auto-tractor and other branches: the difference between his own and Sorokin's position was, he implied, one of emphasis¹.

By November 1931 Al'perovich had moved cautiously in the direction of the 'American' specialisation tendency. The machine tools built by capitalist firms were, he wrote, excessively universal, being built to meet an uncertain demand and designed to satisfy all possible requirements of users. Competition and patent law tended to induce irrational product differentiation and a low level of standardisation of parts, Universalism was also fostered by the building of machines for colonial and semi-colonial markets (the British industry was clearly in mind here) Al'perovich regretfully observed that Soviet practice of placing orders abroad also revealed a striving for the acquisition of machines of excessive complexity and universality indicating that the work for which they were intended was not known. Soviet industry, he concluded, needed universal machines for the purposes outlined earlier, but, "an ever larger part of the machine tools for industry must have either a quite narrow production purpose or possess some, extremely limited universality".² Al'perovich stressed the need to rapidly organise design work on types of a more specialised nature than those then in production, including multi-tool lathes, semi-autos and simplified milling machines. American models were to be copied, but converted into metric terms and to Soviet standards.

It is impossible to trace the evolution of Al'perovich's views and the policy of the branch in 1932-33 without examining a number of related events of the period. At the Seventeenth Party Conference in January-February 1932 a number of speakers called for the building of high-grade, special and specialised machine

Perhaps, as a result of this, between the future socialist machine building technology and present day capitalist technology there will be a difference such as that between the European alphabet and its thirty or so letters which one may combine to express any word or thought, and the Chinese alphabet, with its thousands of characters, almost one for every separate word" - VARNITSO, 1931 No.3, p.21.

6. Spetsializatsiya i kooperirovanie v mashinostroenii SSSR, M.-L., 1931, p.47.

7. TsIT i ego metody NOT, M., 1970, p.125.

8. ZaInd., 22.6.1932.

9. e.g. ZaInd., 5.8.1930; 12.9.1930.

1. ibid., 4.4.1931.

2. ibid., 7.11.1931.

tools, including automatics and semi-autos.¹ G.Vol'pert, writing in Pravda in February, called for the building of tens of types of powerful and special machine tools not then foreseen in future plans.² But the most important event for technical policy was the outbreak of public discussion about the new standard 'DIP' lathe just entering production at the 'Krasnyi Proletarii' factory. This debate began in February and ended in a public 'trial' of the machine in March.

The new standard lathe was basically a copy of the German 'VDF' lathe, probably the best toolroom and general-purpose machine of its type of its day. Critics of the choice of this model for Soviet production charged that it was excessively universal and complex and, because of this, too expensive. It was difficult to build and required quite highly skilled workers for its operation and maintenance. It was, in fact, a classic example of 'European' machine tool technology. Defenders of the 'DIP' pointed out that there was a large demand for such machines for toolrooms, repair shops and general machine building; that the building of the model represented a tremendous advance for Soviet machine tool building, and that it was sound policy to first build machines of great complexity because this performed an invaluable training function for workers and specialists so that subsequent models would present no difficulty.³ Shortly before the 'court' on the lathe the technical council of Stankooob'edinenie under Al'perovich's chairmanship issued a decree on the discussion, acknowledging the importance of the questions raised, in particular the fact that it was important to eliminate excessive universality and complexity. But in essence the decree was a defence of the 'DIP' in terms similar to those outlined by Al'perovich in the previous year: Soviet industry required large numbers of high-grade, universal toolmaking lathes. But it was decided that this model would represent no more than thirty per cent of total lathe production. The decree also acknowledged the correctness of the principle of building machines of more narrow or special purpose by assembling them from standard assemblies made on a large-serial basis, and of building simplified variants of standard machines like the 'DIP' giving more specialised equipment. The 'court' appears to have endorsed these conclusions: the 'DIP' represented a new stage in the development of the Soviet machine tool industry, but the 'DIP' could not be the sole

product of the 'Krasnyi Proletarii' factory because Soviet industry required more specialised machines.⁵

The 'DIP' debate and the widely publicised 'court' pushed the question of technical policy for the machine tool industry to the forefront and this, coupled with initial estimates of the demand for machine tools during the Second Five-year Plan, appears to have made the NKTP leadership, and Ordzhonikidze in particular, receptive to proposals for a change of course. By May it seems that a target of 70-80,000 units output in 1937 had been provisionally adopted, with considerable emphasis on the development of large-serial and mass production in machine building. The events of May-June 1932 are unfortunately rather obscure, but it appears that a young engineer, G. Shaumyan, presented a report to Ordzhonikidze sharply critical of the widespread enthusiasm for universal machine tools and strongly arguing the case for building automatics, semi-autos and other high-productivity types. After reading this report Ordzhonikidze called a meeting of interested parties in NKTP. This was apparently a stormy gathering, a number of leading workers of the Commissariat arguing against Shaumyan's report; but it was adopted. Ordzhonikidze rewarded Shaumyan with a new flat, and shortly after on 1st June 1932 the NKTP Order No. 407 appeared, setting out policy for the development of the machine tool industry.⁶

The NKTP Order outlined the main lines of technical policy for the branch during the Second Five-year Plan. Stankoob'edinenie was to start producing special machine tools for the auto-tractor industry. Particular attention was to be devoted to the building of grinding machines, gear-cutting machines, automatics and semi-autos. The best European and American models were to be taken as a basis for selecting types for domestic production; they were to be chosen from those models imported into the USSR in quantity and already proven in use. There was to be a maximum standardisation of parts and the use of standard assemblies.⁷

1. XVII konferentsiya VKP(b), st. otchet, M., 1932, pp. 195; 234.

2. Pravda, 11.2.1932.

3. For arguments for and against, see Khavin, A., Kratkii ocherk istorii industrializatsii SSSR, M., 1962, p. 238; Byli industrial'nye, M., 1970, p. 157; Gudev, I., Sud'ba rabochego, M., 1970, p. 40; Kas'yanenko, V. I., Bor'ba trudyashchikhsya SSSR za tekhnicheskuyu nezavisimost' promyshlennosti, 1926-1932gg., M., 1960, pp. 29-30.

4. SiI, 1932, No. 2, p. 26.

5. Khavin, op cit; 15 let bor'by za sovetskoe mashinostroenie, L.-M., 1932, p. 41.

The June 1932 NKTP can be seen as an official call for a change of technical policy, but it by no means signified that the specialised machine tool industry as a whole had accepted that a change of course was necessary. The circumstances leading to the order were hardly conducive to gaining whole hearted support within the industry for the major innovation effort demanded. The intervention of a young outsider must have been deeply resented and it seems likely that Al'perovich himself was one of the leading workers of the Commissariat (he was a member of its collegium) who opposed Shaumyan's report. At the first conference of designers in July he referred to the fact that there had been a 'legislated' solution to the problem of technical policy, which may well have indicated his personal reservations. Nevertheless, at this conference he outlined a provisional output structure for the final year of the Second Plan which marked a very considerable break with previous practice: turret lathes, automatics and semi-autos were together to represent no less than 16 per cent of total output, and grinding machines up to 15 per cent.⁸

The change of policy outlined in the June 1932 order was linked with a 1937 output target of 70-80,000 units. In the subsequent months, and especially the early months of 1933, this aim was progressively scaled down. At the same time pressure for the elimination of import dependence steadily mounted. These two factors had serious implications for the policy of the branch. First, the reduction of output targets and the general rate of development of the economy meant that the industry could not so easily solve the problem of building high-productivity machines by constructing new specialised factories - such machines would have to be assimilated by existing enterprises. Second, import substitution demands required that a large range of new types be introduced in a very short period of time, in particular those needed by the large-serial and mass production branches for which import dependence was greatest. Writing in March 1933 Al'perovich fully acknowledged that a real change of course was essential.⁹ The building of a few simple machines had to cease; a base for building automatics had to be organised; machines had to be built to meet the specific requirements of customers,

6. See *Byli industrial'nye, op cit*, pp.157-158 (memoir of A.S.Britkin), and *Ocherki razvitiya tekhniki v SSSR - mashinostroenie, ..., M., 1970, p.76.*

7. *SiI*, 1932, No.7, p.2.

8. *ibid.*, 1933, No.1, p.1.

and machines of 'limited application' had to be assembled from standard assemblies. Al'perovich had now embraced many of the demands of the 'American' tendency, and in his last point had even moved towards Gastev's position. Shortly after this Sorokin reentered the debate, once again calling for the production of a range of specialised high-productivity types, including unit-construction machines.¹ On 16th June 1933 a new NKTP order appeared, setting out policy for the branch during the Second Five-year Plan: it is this measure, and not the order of 1932, which marks the transition to a new stage of policy with regard to the choice of machine tool technology.

Mid-1933 - 1935

The NKTP order of June 1933 noted that machine tools built to date had been predominantly of a universal type; many types were not produced at all, including grinding machines, automatics, semi-autos, and special and simplified machines suitable for use in mass production. These types were now to be built, taking the best American and European models as a basis, with a stress on simplicity of design, ease of control and suitability for the use of standard assemblies.² This order marked the beginning of the transition to the production of more specialised types, but in the period 1933 to early 1935 debate continued on the question of the emphasis to be placed on high-productivity/as opposed to the universal types then still dominating the Soviet industry's output. The 'universalist' tendency was undoubtedly still a force, and as before there were still others who placed one-sided emphasis on the use of more specialised equipment. In 1933-34 there were a number of proposals for a more balanced approach tailored to the specific needs and possibilities of Soviet industry. Thus Orentlikher on a number of occasions argued that Soviet industry still required large numbers of universal-type machines to meet the needs of the repair shops, FZU schools, toolrooms and factories of general machine building, and declared that relatively more such machines were required in the USSR than in the USA.³ But at the same time Orentlikher argued for much greater emphasis on specialised types required

9. SiI, 1933, No. 4, p. 1 'Perelomnyi moment'.

1. ZaInd., 3.4.1933.

2. Industrializatsiya SSSR, 1933-1937, p. 248.

3. ZaInd., 15.12.1933; Planovoe khozyaistvo, 1934, No. 8-9, p. 30.

by the large-serial and mass branches, calling for the production of both complex automatics, multi-tool and multi-spindle machines and simplified, operational machines. Orentlikher believed that the scope for the use of simplified machines for specific operations was greater in the Soviet Union than in capitalist countries. Operational machines could, he argued, be obtained by simplifying universal machines by removing lead screws, reducing the number of feeds and speeds, etc., giving the possibility of producing them quickly and cheaply using quantity production methods.¹ Thus Orentlikher presented a synthesis of three tendencies - for universal machines, and for specialised, the latter in both its 'American' and simplified, special machine variants.

At this time Kaganovich also argued the case for building both American-type high-productivity, specialised automatics and semi-autos and also special operational machines for use in large-serial and mass production. On the former he called for the building of machines combining operations, and machines combining several machining units in one installation with automatic transfer mechanisms between the units.² Unlike Orentlikher, however, Kaganovich did not refer to the continuing importance of universal machines, persisting in the forthright 'Americanism' which he had always advocated. Al'perovich, on the other hand, maintained a more balanced position, although he showed a tendency to stress the importance of high-productivity specialised types with more vigour than in the previous period. The auto-tractor branch, he now stressed, was the most important machine tool user and therefore determined the line of technical development. Cheap machines of the standard, universal type could be used for making motor vehicles and tractors, he observed, but it was far more profitable to design and build on an individual and small serial basis specially tooled-up automated machines of narrow purpose in order to secure low cost machining of mass produced parts. Thus he concluded that "...the main task of machine tool building consists in achieving a minimum cost of machining components, even though the complex and highly productive machine tools created for this purpose will turn out to be relatively expensive".³ On the other hand, he pointed out that a large number of

1. Planovoe khozyaistvo, 1934, No. 8-9, pp. 30-31.

2. Ibid., 1934, No. 3, p. 27; XVII s"ezd VKP(b), st. otchet, M., 1934, p. 472.

3. Izvestiya, 27.5.34.

universal machines was still needed, the scale of demand being sufficient to justify their serial, but not mass, production.

Anti-universalism tendencies began to emerge at the level of the machine tool building enterprise in the summer of 1934, when a public controversy flared up over the Glavk's technical policy, focusing on the choice of models to be built at the new Khar'kov factory. Representatives of the enterprise claimed that the radial drilling machine model chosen by ENIMS was excessively complex and universal and featured unnecessarily complicated controls¹. The director of the im.Sverdlova factory, Kalashnikov, also argued that models being produced were excessively universal and therefore not suitable for use under Soviet conditions.² However, others were prepared to defend the universalism of the machines criticised on the grounds that it was best to first build such highly complex machines, and that universal machines served to teach workers the skills of machining.³

At the end of December 1934 an order was issued by NKTP providing for the construction of Soviet machines to meet the needs of the planned expansion of the auto-tractor factories.⁴ These machines were to be of a predominantly high-productivity, specialised type. The eighteen months between June 1933 and the end of 1934 can be regarded as a transitional period in which the first examples of specialised, high-productivity machines were built and a foundation laid for their regular production. With the new order the specialised machine tool industry made a further step in the direction of adopting the 'American' path advocated by Kaganovich and Sorokin.

1935 - 1941

The implications of the NKTP order were discussed at the Third Conference of Designers in March 1935. Writing just before the conference Sorokin once again declared that high-productivity, automatic and semi-automatic machines had to predominate in the tipazh. Over half the machine tool stock of the country was located at engineering industry enterprises and, he claimed, 72 per cent of these machines were at large-serial or mass production factories; this sector had to

1. ZaInd, 24.5.1934.

2. ibid, 2.6.1934.

3. ibid, 24.5.1934; 22.6.1934.

determine the profile of the Soviet machine tool industry. But, he also stressed, contrary to a widespread prejudice the use of high-productivity machines went far beyond the motor industry; such models as the Fay, Baird, Cone and Bullard automatics, the Blanchard surface grinder, the Cincinnati centreless grinder and the Gleason gear-cutting machine could be used in many other branches of medium engineering having serial or mass production. The fact that at the time many factories showed a bias towards simple machines was, he added, no grounds for accepting that their use was correct.⁵

The conference of designers was mainly devoted to discussion of the allocation of a tipazh of specialised, high-productivity machines between enterprises, and also the question of unit construction machine tool building. In a report delivered at the conference on foreign machine tool developments an engineer, Kashirin, noted that more productive equipment was finding increasing application in Europe. Foreign practice was also cited in support of the view that high-productivity equipment could be used in large-serial as well as mass production. It was noted, however, that there were some American machines having a productivity almost unusable in Soviet conditions; e.g. there were machines with an output rate of two hundred parts per hour - even at the expanded Gor'kii auto factory there would be only four positions requiring such a high productivity. Ambitious targets were adopted by the conference: the entire tipazh for the auto-tractor factories had to be assimilated in 1936; the leading factories had to switch predominantly to the output of high-productivity machines.⁶

At about this time the specialised machine tool industry also appears to have accepted the necessity of rapidly developing unit-construction machine tool building. Gastev, with some irony, observed that almost at once machine tool builders had reorientated to unit construction after seeing the advanced machines installed at the Citroen factory in France; irony because this was the path he had been advocating for the last three-four years.⁷ The branch began building unit-construction machines, but did not apply the principle in the thorough going way demanded by Gastev and the TsIT workers.

4. Bol'shevik, 1935, No. 6, p. 13.

5. ZaInd., 20.3.1935.

6. Ibid., 22.3.1935.

7. Organizatsiya truda, 1935, No. 6, p. 2.

The conference of designers marked the achievement of a policy consensus; high-productivity machines were to be the main focus of the leading factories of the specialised machine tool industry, unit-construction machines were to be developed, but universal-type machines would still be built. On the latter point even Kaganovich conceded that during the First Five-year Plan years the building of universal types for the use of repair shops and general machine-building could not, "be held against machine tool building of that time, because we will produce these types of machine tool equipment in a certain quantity in all circumstances in the future".¹ The conference was followed by a campaign against reliance on universal machines at large-serial production enterprises, interpreted by the newspaper ZaIndustrializatsiyu as a drive against European machines. The 'Krasnyi Proletarii' factory was accused of building German-type machines as opposed to American; German universal machines with complex components were considered inappropriate.² The Mosgipromash was condemned for projecting the new Orsk locomotive and diesel engine factory for the installation of equipment of predominantly German and British origin, whereas, it was claimed, equivalent American enterprises were equipped with high-productivity machines of American types with much differentiation of operations. The project organisation defended its policy by pointing out that European equipment was better known, and that highly specialised equipment had been deliberately rejected because in the event of design changes processes would have to be revised: it was easier to use general-purpose equipment in serial production.³ This exchange was hardly a convincing demonstration of the irrationality of universal equipment. The nature of the 'universal' machines was not discussed by the newspaper, which also vaguely talked of 'narrowly specialised' machinery; if this was seriously regarded as suitable for the enterprise in question then the project organisation can hardly be blamed for rejecting it.

In the second half of 1935 and in 1936 there was little discussion of the question of which type of machine tool to build. Factories were striving to build the new specialised, high productivity machines, and at the same time some

1. Bol'shevik, 1935, no. 6, p. 13.

2. ZaInd., 14.6.1935.

3. ibid., 30.3.1935.

leading factories were also attempting to assimilate new, improved, general-purpose models. There were still complaints about the alleged excessive universality of the machines produced, notably by representatives of the motor industry. Thus, two 'ZIS' factory engineers criticised the lathes built by Soviet factories for their large number of feeds and speeds; simplified lathes were required, they stressed, with a limited number of feeds and speeds, and without lead screws.¹ With the development of the Stakhanovite movement demands appear to have changed to some extent in the opposite direction. Now workers were demanding machines with a large range of possibilities, having fully mastered the skills of machining. Thus, the 'Krasnyi Proletarii' factory's replacement for the 'DIP', the Type 26, described in 1936 as a 'Stakhanovite' machine because of its more limited speed and feed ranges², was condemned in the following year for not meeting Stakhanovite demands for an increased number of speeds.³

Policy for the Third Five-year Plan as seen in 1937 followed the already determined path, but with greater emphasis than ever on high-productivity types and a more marked stress on the automation of machines of all types. Al'perovich, reviewing the position reached and future prospects in May 1937 noted that at least half of the machines built during the next Plan period had to be suited to the use of super-hard alloy tools, all machines had to be electrified, at least one-fifth of all 'so-called' general-purpose machines had to be converted into semi-autos, and at least 80 per cent of specialised and special machines intended for specific operations also had to take the form of semi-automatic models.⁴ This stress on semi-autos appears to have been promoted by the need to reduce the skill demands posed by new machines and may well have been influenced by military production considerations.

There is no doubt that in the Third Five-year Plan period military production considerations exerted a strong influence on machine tool technology choice policy. This question is discussed at length in Appendix 5. The great stress on automatics and semi-autos evident at the Eighteenth Party Congress⁵, and in the

1. ZaInd., 22.10.1936.

2. SI, 1936, No. 8, p. 5; ZaInd., 22.9.1936.

3. Planovoe khozyaistvo, 1937, No. 7, p. 42.

4. ZaInd., 8.5.1937.

SNK decree of September 1939 can probably be ascribed to concern with meeting the demands for high-productivity equipment of a skill saving nature required by such branches as the small arms and munitions industry and the aircraft industry. The SNK decree was critical of the inadequate supply of special and high-productivity machines ; this was hindering the adoption of progressive technology in the engineering and defence industries. The decree laid down guidelines for the coming period, which included provision of greater power and higher speeds of cutting, full electrification, the automation of control, the use of standard assemblies, and also made a call for the rapid organisation of the building of high-productivity machines for use in mass production, primarily those required by military branches, including narrowly specialised machines for specific operations multi-tool, multi-spindle, and unit construction machine tools.⁶

Simultaneously with this stress on high productivity types (to a greater extent than ever before), a policy of modernising, automating and simplifying general-purpose machines was adopted. Providing universal machines with devices greatly simplifying their control facilitated the development of multiple machine manning with the aim of making the most efficient use of skilled machine operators. The simplification of older general-purpose machines for use by workers of low skills by converting them into highly specialised operational machines was adopted as policy in the engineering and defence industries.⁷ Thus the policy of creating simple, highly specialised machines advocated by Pankin in 1930 was taken up in practice ten years later; the machine building factories now had the skills and resources to carry out this work themselves without relying on the specialised machine tool industry.

We are now in a position to summarise the evolution of machine tool technology policy in the pre-war years. Prior to 1929 emphasis was placed on general-purpose types, although there were demands for the use of 'production' machines; between 1929 and mid-1933 a number of lines of policy were put forward, ranging from advocacy

5. The building of autos and semi-autos was stressed in the theses to Molotov's report to the Congress, in Malyshev's report and in an interruption of the latter by Stalin, who expressed concern at the apparently small proportion of such machines in total output (XVIII s"ezd VKP(b), st. otchet., M., 1939, pp. 386-387)

6. Direktivy KPSS i Sovetskogo pravitel'stva. , op cit, Vol. 2, pp. 601-603.

7. Mashinostroenie, 16.1.1940; 17.1.1940; 9.2.1940.

of universal types to a radical rejection of all existing practice, but with mounting emphasis on the need to build American-type high-productivity machines of a more specialised nature. By mid-1933 the building of such machines had been posed as an immediate task for the machine tool industry, but this policy was only pursued with vigour from the beginning of 1935, when a policy consensus in favour of priority for more specialised machines was achieved. In the years 1935 to 1941 specialised, high-productivity machines were given priority, unit-construction machines were built, and mounting emphasis was placed on the automation of machine tools as the demands of military production intensified and the problem of the supply of skilled labour became more acute. Throughout the Second and Third Five-year Plan years the building of universal machines of modern design was also regarded as essential, but the appropriate degree of universality was a matter of debate. Finally, in the immediate pre-War period the making of operational machines by simplifying and adapting general-purpose models became official policy in both civilian and military branches of the engineering industry.

The Choice of Machine Tool Technology at the Level of the Enterprise

Before considering the practice of technical choice it is necessary to examine the actual procedures adopted in selecting equipment for any given enterprise. In the case of the selection of machine tools for installation at engineering factories it is possible to deduce both 'normal' and 'best' practice from a number of cases cited in the literature; these cases generally refer to the motor industry.

A useful general statement of the problem was provided by an engineer, N.M. Gradusov, in an article published in December 1932.¹ Gradusov gave an account of the usual procedure for choosing machines. Technological processes for the machining of components were elaborated by protsessniki on the basis of data and specifications on the items to be made. The protsessnik determined the processes to be employed, the machine tool, the necessary fixtures and cutting and measuring

1. SiI, 1932, No. 12, pp. 8-11.

tools, and the regime of work to be adopted. On the basis of the data provided by the processman, the rate fixer (normirovshchik) established the time required for the various operations involved. As Gradusov pointed out, this division of responsibility deprived the processman of the possibility of taking account of one of the most important variables, i.e. the choice of the best method of machining from the point of view of the time expended. The ideal solution, in his view, was for one person to undertake both tasks. When the processes for all components and the equipment required had been decided, the final stage of project work was the establishment of the number of machines needed, the aim being to secure a maximum rate of utilisation of each machine tool. In practice, Gradusov admitted, processmen were not as a rule acquainted with all the machines available on the market, with the result that many project organisations vested the choice of specific models with one man, a vyborshchik, who had a detailed knowledge of the range of equipment available.

Gradusov listed a number of factors which had to be taken into account in selecting machine tools. First, there was the problem of which country and firm machines should be obtained from: Soviet machines were preferable but, ironically, information about them was often extremely difficult to find. In choosing equipment a simple rule was followed: buy German machines when standard, relatively cheap and average or low quality equipment was applicable, but American models when special machines or standard machines of higher quality were required. Thus, in practice the procedure outlined by Al'perovich in the 'twenties was apparently widely followed. Other countries were to be regarded primarily as sources of special machines. Second, the degree of automation had to be fixed, e.g. should normal lathes, turret lathes or automatics be employed? The decisive factors, according to Gradusov, were the number of components to be machined and the productivity of the equipment. More accurate solutions to the problem required data on the price of machines, operational costs, setting up times, etc., and it is clear by implication that in practice such information was often not taken into account. Gradusov noted that ignorance of the possibilities of automatic machines from the point of view of setting up and retooling frequently led to their

rejection and resort to more 'understandable', simple machine tools. Other factors to be taken into account included the precision of the work, the quality of the machines, the relationship between mechanical and hand operations (the latter to be reduced to a minimum), and finally, what Gradusov termed the two neglected aspects of machine choice - the 'loading' of machines and their price. On the former, he noted that the unutilised foreign equipment revealed at some enterprises in recent times showed that insufficient attention was devoted to securing maximum utilisation at the stage of projecting. The loading of individual machines could only be determined at the end of the project work by summing the time expenditures for all components. It was therefore out of the hands of the individual processman, although as Gradusov pointed out, it was precisely at this last stage that the degree of specialisation of equipment was determined. However, he did not draw the necessary conclusion - the pursuit of maximum utilisation of each and every machine would lead to a bias in favour of the adoption of universal-type equipment. On the question of prices, Gradusov noted that the demands of khozraschet at the level of the enterprise made it imperative to take account of the price of installed equipment. In practice, however, project workers did not the prices of machines or the financial terms of their acquisition.

From this account a number of conclusions can be drawn. First, the selection of equipment was approached pragmatically, with technical considerations playing a dominant role; little attention being devoted to economic aspects. Second, while the price of equipment was a relatively secondary concern of project workers, there is no reason to assume, a priori, that there was a bias towards expensive and excessively specialised equipment - on the contrary, known, simpler, universal equipment was preferred to more complex, automated machinery, even though in practice this probably resulted in a higher capital-output ratio than would otherwise have been the case. Third, in determining the degree of automaticity machines the basic factor taken into account was the scale of output of the given component; cost considerations were secondary. The overall impression is that in normal practice rule of thumb methods prevailed with technical expediency

taking precedence over economic considerations.

In the case of high priority, large-serial and mass production enterprises employing much foreign equipment a more rigorous procedure appears to have been adopted and from accounts of specific cases more can be deduced about 'normal' practice. A good example of the selection of equipment for a priority project is provided by the case of the reconstruction of the 'AMO' vehicle factory in Moscow in 1930-31, described in January 1931 by M. Sorokin.¹ This major reconstruction was based on American practice with adoption of the flow principle, while the methods of machining represented, "...the last word in this field (with account, naturally, of the scale of production)". Special attention, claimed Sorokin, had been devoted to the use of labour-saving mechanisms. But the main thrust of Sorokin's account was an attack on the prevailing practices of machine selection, which, he considered, were in need of a radical review. "We frequently strive", he wrote, "to 'smooth down' equipment in accordance with the magnitude of the production assignment. As a rule such an approach is fundamentally incorrect, because it entails solving the problem by the line of low-productivity equipment. In the conditions of modern technology it is frequently more expedient to adopt more productive equipment, and go for its deliberate temporary idleness, rather than buy less productive mechanisms with the aim of their one hundred per cent utilisation".² This was to be a point of contention throughout the decade; was it right to buy expensive equipment, often involving large foreign exchange outlays, even though part of the time it would be idle? Sorokin found it necessary to demonstrate that such an approach, at first sight wasteful, was in fact economically rational.

Sorokin provided a number of real life examples of the adoption of specialised, labour-saving machine tools for the AMO reconstruction, the projected capacity of which was for an output of 100 vehicles a day. For the boring and reaming of gudgeon pin holes of pistons (600 pistons a day) two alternatives were available; first, the use of two turret lathes, together costing 7,500 rubles and requiring

1. Novaya tekhnika, No. 2, supplement to ZaInd., 9.1.1931.

2. ibid., original emphasis.

two workers for their operation, the machining of each piston requiring 2 minutes; second, the use of one four-spindle machine (semi-auto?) costing 7,500 rubles and requiring one worker. This latter machine permitted the machining of four pistons at a time, the operation lasting half a minute. The second method was selected for AMO on the grounds that it was both capital and labour saving, the capital saving being obtained because the production area for one machine was freed. In another case of machining the housing of an oil pump the alternatives were, first, four single-spindle, vertical drilling machines costing about thirteen thousand rubles and operated by four workers, producing four parts an hour, and second, one multi-spindle, multi-station machine operated by one worker (less skilled), giving a higher output than four machines together and costing about 20,000 rubles. It was considered that the saving of three workers and of productive area, and the higher rate of output, justified the choice of the latter. But the most productive method was not always selected; in the case of milling the ends and caps of connecting rods a technique was adopted which gave an output of one hundred sets a day with one worker, although other methods were available giving a much higher productivity - "For the scale of production at the AMO factory the chosen method is the most profitable". Thus the project workers responsible for the AMO factory reconstruction adopted a flexible approach, tailoring the machine tools installed to the scale of output and, while accepting the viability of using specialised, high-productivity equipment at less than full load for some functions, rejected such equipment when less productive methods gave a satisfactory rate of production. It is interesting to note that an American expert wrote in 1932 after a visit that the AMO factory was, "... by far the largest and best equipped plant in the world devoted solely to the manufacture of trucks and buses. Basically, the equipment is the last word in American practice".¹

A very similar approach appears to have been adopted in selecting equipment for the Gor'kii automobile works (GAZ), although in this case there does appear to have been a more definite striving ^{for saving} of capital or, at least, of foreign exchange expenditure. It was acknowledged that Ford production technology could not be directly copied because the scale was much smaller and the GAZ works was

1. Automotive industries, 12.3.1932, p.419.

a fully integrated plant.¹ The scale of the GAZ factory was, however, considered great enough to permit the widescale adoption of the flow principle. It was claimed at the time that considerable cost savings were obtained by rejecting excessively specialised equipment; for machining gear box components alone a saving of 270,000 dollars was achieved. Much of the equipment was identical to that used at the Ford factories, however, for the simple reason that Ford was at the time switching from the Model A to the new V-8 models, and a considerable quantity of second hand machinery, tools and dies for the former was sold to the USSR for the GAZ factory - an additional capital and foreign exchange saving factor.²

A third case of the selection of equipment for a vehicle factory, in this instance a light car works, is the im.KIM car plant built on the basis of a small, existing assembly factory in the years of the Third Five-year Plan.³ The technological processes of this integrated plant were projected for an annual output of 60,000 units a year, or 200 a day, with the adoption of the flow principle to a wider and deeper extent than at any existing Soviet vehicle factory. It was acknowledged that the machining of components could be undertaken most cheaply if the latest, high-productivity, automated machine tools were employed, but at the same time it was recognised that with a daily output of only 200 cars a day such equipment would be loaded to only 30 - 40 per cent. Demyanyuk therefore found it necessary, as Sorokin had nine years earlier, to argue against the prevailing approach to machine selection: "In approving technical projects it is usual to require that the average utilisation of equipment in machine shops be not less than eighty per cent. If instead of special machine tools one took simple machines with fixtures, the coefficient would at once improve, but the time of machining the components would be increased two-fold, The number of machines would also grow, a greater area would be required, and also more workers to man the machines. Even the outlays on purchasing equipment would not always be lower".⁴

1. Planovoe khozyaistvo, 1932, No. 6-7, p. 255.

2. See Wilkins, M. and Hill, F., American business abroad: Ford on six continents, Detroit, 1964, pp. 223 and 227; and Sorensen, C. and Williamson, S., Forty years with Ford, London, 1957, p. 208.

3. Mashinostroitel, 1940, No. 4, pp. 3-6. Demyanyuk, deputy chief engineer im.KIM factory.

4. ibid., p. 4.

Demyanyuk provided a number of examples to show the expediency of buying high-productivity equipment despite relatively low rates of utilisation. For turning the carriage of a gearbox synchromesh mechanism, for example, two alternatives were available: first, the use of three suitably tooled turret lathes of total cost 9,500 dollars, with a machining time of eight minutes and a rate of utilisation of 80 per cent for each machine and, second, the chosen variant, a Baird multi-spindle, semi-automatic lathe costing 7,500 dollars giving a time of machining of only 1.56 minutes and a utilisation rate of 56 per cent. Under conditions of two shift work the first variant required six workers; the second, only two. In the second case the required production area was halved. Thus despite the lower rate of utilisation the second variant was considered the more rational choice, while, "The low coefficient (of utilisation) is our reserve capacity". The scale of production was not considered adequate, however, to justify the employment of a number of progressive types such as surface broachers and rotomills. Only 26 ordinary lathes were installed out of a total stock of 1,153 machine tools, and the structure of the stock by degree of specialisation was as follows: universal machines 35 per cent, specialised machines 40 per cent, and special machines 25 per cent. In the interests of labour saving, multi-manning was adopted wherever possible, the layout of equipment being deliberately arranged to facilitate this form of machine use.¹

A number of conclusions can be drawn from these three examples drawn from the experience of the motor industry. First, the normal procedure placed considerable emphasis on the need to secure a high rate of utilisation of equipment, with a consequent bias towards more universal, less productive machines; this was not necessarily the best solution from the economic point of view in so far as it raised the demand for skilled labour and in many cases must have resulted in a higher capital-output ratio than would have been the case if more specialised equipment had been used. Second, for the mass production vehicle factories a case had to be made for breaking with this rule in order to justify the installation of high-productivity machines: such machines were in fact installed and, as shown in Appendix 4, this gave the Soviet vehicle industry a stock of very similar

¹ ibid.

structure to that of the United States motor industry. Third, in selecting machines considerable stress was placed on the scale of output of components as the main determinant of technology; project workers, while aiming for the 'best' most modern technology, selected machines appropriate to the given scale and were prepared to reject variants excessively productive for any given operation. Fifth, the capital-saving possibilities of specialised and special, high-productivity machines were acknowledged in all three cases, and attention was paid to other sources of capital saving, notably savings in factory floor space. Sixth, in the cases of both the AMO and im.KIM factories (and possibly GAZ - information is lacking) labour saving, in particular economy of skilled labour, was regarded as an explicit aim in selecting equipment. Finally, in all three cases the principle of arranging machines according to the flow of work was adopted wherever appropriate.

The Practice of Machine Tool Choice

This section is devoted to an examination of the evidence on the actual practice of machine tool choice in terms of the structure of the machine tool stock and new installations in different periods.

Before 1929

On the basis of the data of the 1932 machine tool census it is possible to discern the main features of the practice of machine tool choice during the restoration period preceding the First Five-year Plan. Some caution is required in so far as the data refer to those machines of the April 1932 stock which had been installed before 1929, so that the structure may have been modified to some extent by the relocation of some machines and also by withdrawals from the stock, although the latter are believed to have been insignificant. The main features of the machine tool installations of the 1918 to 1928 period were as follows:¹

1. See Appendix 3 for a more detailed analysis of the findings of the census.

1. Quite a high proportion (45 per cent) of all installations prior to 1929 were in non-machine building and metal working sectors. Of the machines installed in the machine building industry over one quarter went to only three branches - the building of locomotives and wagons, electric power equipment, and agricultural machinery. New installations were predominantly directed to branches of small and medium serial production. Thus, from the structure of user branches and sectors one would not expect the employment of highly specialised, high-productivity equipment.
2. Of the total number of machines installed, almost 70 per cent were of foreign origin, including three-quarters of those installed in machine building and other metal working branches. Imports were overwhelmingly of German origin.
3. Few of the machines installed in the machine building industry during 1918 to 1928 went to new enterprises founded within that period; about 85 per cent went to enterprises founded before the Revolution.
4. The main emphasis was placed on machines of wide universality, although at new enterprises founded during the period slightly more emphasis was placed on types of intermediate specialisation suitable for operation by semi-skilled workers.
5. At new enterprises founded within the period rather greater use was made of simple machines without power feed than during the pre-Revolutionary years (or the subsequent Plan period), furthermore, somewhat greater use was made of automatic and semi-automatic machines.
6. The structure of types of machines installed in the 1918 to 1927 period did not differ in any significant respect from the structure of installations made before the Revolution: the proportion of ordinary lathes was virtually unchanged, that of milling machines and gear-cutting machines declined, but the share of such progressive types as automatics and grinding machines showed a slight improvement. In 1928 the structure improved: the share of ordinary lathes fell and of grinders rose sharply, starting a trend which was maintained during the following Five-year Plan.

7. The universal nature of the machines installed during the period naturally resulted in a relatively high average skill requirement. At enterprises founded during the years 1918 to 1928 the average skill of workers manning machines in the production shops in April 1932 was 3.2 (on the eight point scale), compared with 3.1 for enterprises established before the Revolution, while the proportion of workers of relatively high skills (grade 4 and over) was about the same as at the earlier enterprises, i.e. the machines installed in the years prior to 1929 did not give rise to the process of deskilling which characterised the engineering industries of other countries in the 1920s.

In general, we can say that on the evidence of the 1932 census there was little change in the practice of machine tool choice compared with that of before the Revolution. At a time when attention in the engineering industries of the industrially advanced capitalist countries was turned to 'production' machines manned by semi-skilled workers the Soviet industry continued to employ low-productivity, widely universal machines requiring relatively high worker skills.

The First Five-year Plan

The primary source of evidence on the practice of machine tool choice during the first Five-year Plan period is again the 1932 census, taken in April of that year and partially updated to 1934 before its publication in 1935. Unfortunately the stock of the military sector was excluded. The main conclusions of relevance here are as follows:

1. During the Plan period almost two-thirds of all new machines installed went to the machine building and other metal working branches; the remainder going to lower priority sectors (mainly for repair purposes), having much lower qualitative demands and relying overwhelmingly on relatively simple, universal types of machine tools. Within the machine building sector, almost thirty per cent of all new installations went to only three branches - the making of automobiles, tractors and agricultural machinery - characterised by a very high level of seriality of production and a wide adoption of the flow principle of machine arrangement.

2. During the period 58 per cent of all new installations were imported machines compared with 70 per cent in the preceding 1918-1928 period. In the machine building and other metal working sector, however, 64 per cent of installations were of imported machines, compared with only 45 per cent in other sectors of the economy; over seventy per cent of all imported machine tools during the Plan period went to the metal working sector. Almost thirty per cent of all imported machines installed in machine building and other metal working were of American origin, compared with just over one fifth in the preceding period.
3. Of the new installations during the Plan period, 37 per cent went to new enterprises founded during the period itself; while over half, 52.5 per cent, were used for the reconstruction and expansion of enterprises founded before the Revolution.
4. New installations in machine building went predominantly to branches characterised by mass or large serial production of light or medium products (by weight). These branches tended to have an above average use of flow organisation: the above mentioned three leading branches possessing no less than 55 per cent of all flow-arranged machines in April 1932.
5. During the First Five-year Plan period the proportion of widely universal machines in new installations somewhat declined compared with the pre-1929 years, amounting to one third of all new installations. The main emphasis was placed on types of intermediate specialisation, notably at new enterprises founded in the Plan period itself. Machines of very narrow specialisation occupied a very small place in both the stock and new installations.
6. During the Plan period the share of semi-automatic and automatic machines (notably the former) increased, and reached quite high levels at new enterprises founded within the period, especially at the mass production auto-tractor factories. Quite a significant role was played by relatively simple machines without power feed, notably in branches producing light, high precision products on a mass or large serial basis. These machines could be operated by workers of relatively low skills despite the precision of the products concerned.

7. The structure of types of machines installed during the Plan period changed substantially compared with the preceding 1918 to 1928 period, with a marked shift towards progressive types such as automatics, grinding and milling machines and gear-cutting machines, and a corresponding decline in the share of lathes and machines of the planing, shaping and slotting group. This shift was particularly marked at the auto-tractor factories and other mass and large-serial production enterprises developed during the Plan period. The structure of types of newly installed machines at new enterprises founded during the Plan period was much more progressive than that of new machines installed at older enterprises during the same period.
8. A striking feature of the new enterprises founded during the Plan period was the low average skill of workers manning machine tools permitted by the structure of types and degrees of specialisation and automation adopted. Whereas machines in the production shops of enterprises founded during 1918 to 1928 were manned by workers of average grade 3.2, at the new enterprises the average grade was only 2.8 ; in the former case over 30 per cent of machines were manned by workers of grades 4 to 8, but only 16 per cent at the new enterprises. Thus the technology chosen for the new enterprises of the First Five-year Plan permitted large savings in skilled labour: the semi-skilled worker became the dominant figure in production.

During the First Five-year Plan years the Soviet engineering industry made a break with the past and adopted the latest technology of the industrially advanced capitalist countries. A measure of the progress in this direction is provided by comparison of the Soviet and American machine tool stocks at the end of the period. A detailed analysis is provided in Appendix 4 . This shows that machines installed at new enterprises founded in the Plan period had a similar structure to that of the American stock as a whole. This comparison reveals, however, a number of consistent structural differences , above all a relatively higher share of ordinary lathes in the Soviet stock and a related smaller share of grinding machines. These differences can be explained by

the structure and quality of the material input, the supply possibilities for machines of various types, and an avoidance of expensive machines requiring highly skilled workers for their operation. In the high-priority motor industry, relying heavily on imported equipment, the structure of the stock in 1932 was very similar to that of the American motor industry, and it appears that in such high priority branches the latest American technology was adopted almost without adaptation.

During the First Five-year Plan period the machines built by the domestic machine tool industry were overwhelmingly of the general-purpose type, and many progressive types were not produced at all, notably automatics, semi-autos, almost all types of grinding machines, many types of milling machines, broaching machines, gear-cutting machines and cutting-off machines. Domestically produced equipment tended to be installed in the auxiliary shops of the main enterprises, the basic processes being performed by imported machines.

The Second Five-year Plan

The main factor shaping the structure of installations during the Second Five-year Plan period was the sharp reduction in the reliance on imported equipment and the shift of emphasis to supply from the domestic machine tool industry. As noted above the structure of output in machines built in 1932 was extremely backward by foreign standards and the official concern with the necessity to rapidly expand the tipazh at a time when imports were being sharply curtailed is understandable. But in the circumstances the reduction of imports from about 12,000 units in 1932 to 7,750 in 1933 and 4,400 in 1934, despite the reduction of the rate of new installations, inevitably had the effect of reducing the quality of machines installed in all but the most favoured, high priority branches. The trend towards greater specialisation established in the First Five-year Plan years was checked; a process of universalisation of the stock once again became apparent. This process was acknowledged with concern at the time: a ZaIndustrializatsiyu editorial of March 1935 declared that: "The machine tool stock is being

supplemented predominantly by general-purpose machines, especially in recent years in connection with the transition to supplying factories mainly with machine tools of Soviet production".¹ Some of the forces giving rise to this trend are now considered.

The changing structure of domestic production is shown in Tables 5A.VIII and 5A.X. In 1934 ordinary lathes represented 43 per cent of total output, grinding machines 5.3 per cent and milling machines 7.6 per cent. In the course of the Second Five-year Plan period, following the policy laid down by the June 1933 NKTP Order, a whole series of important new models was introduced, including many specialised, high-productivity types. However, the output of the progressive types was still small before 1937 and general-purpose types predominated. Inadequate skills appear to have been the main obstacle to introducing more progressive models; there was a clear correlation between the complexity of each type of machine and the year of its first production, and hence the year when the stock began to be supplemented by Soviet-built machines of a more specialised nature.²

1. ZaInd., 27.3.1935, 18.

2. Evidence for this provided by coefficients of complexity of production of various types of machines, worked out by a Soviet economist, Yu. Moizhes, on the basis of 1939 prices and 1938 actual costs and labour outlays. (Unfortunately the method was not revealed). These coefficients provide a useful indication of the relative difficulty of building different types of machines. A simple bench drilling machine produced by the im. Maslennikova (Kuibyshev) factory was taken as a base. The results are shown below; the year of first Soviet production has been added:

Coefficients of complexity of types of machine tools, 1938-39.

Relatively simple types	coefficient	Medium complexity, cont.	coefficient
1. Bench drilling mc.	1.0 (1929)*	8. Slotting mc. (medium)	8.0 (1934)
2. Shaping mc. (500mm)	3.0 (1929)	9. Broaching mc.	10.0 (1936)
3. Lathe (up to 150mm)	3.0 (1929)	10. Thread-milling mc.	10.0 (1934)
4. Turret lathe (up to 25mm)	3.0 (1931)	11. Lathes (300-400mm)	12.0 (1934)
5. Lathe (150-200mm)	3.8 (1929)	12. Planing mc. (small)	12.5 (1929)
6. Vert. drilling mc. (small)	4.0 (1929)	13. Surface grinding mc.	12.5 (1935)
7. Bolt threading mc.	4.0 (1929)	14. Cylindrical grinding mc.	14.0 (1929)
8. Milling mc. (horiz.)	4.5 (1932)		
9. Lathe multi-tool	5.0 (1933)	<u>Complex Types</u>	
10. Turret lathe (up to 50mm)	5.5 (1932)	1. Lathe, semi-automatic	15.0 (1934)
11. Slotting mc. (small)	5.5 (1929)	2. Boring mc. (small)	15.0 (1934)
		3. Drilling, vert. (large)	15.0 (1936)
<u>Types of medium complexity</u>		4. Radial drilling (medium)	15.0 (1934)
1. Milling (vert.)	6.0 (1933)	5. Surface grinding (medium)	15.0 (1936)
2. Vert. drilling (medium)	6.0 (1929)	6. Internal grinding mc.	15.0 (1935)
3. Turret lathe (up to 80mm)	6.3 (1934)	7. Large lathes (400mm plus)	18.0 (1935)
4. Lathe (275-300mm)	7.5 (1930)	8. Gear-shaping mc.	18.0 (1934)
5. Milling (universal)	7.5 (1931)	9. Vert. turning & boring mc.	20.0 (1936)
6. Disc saw	7.5 (1933)	10. Lathe automatic	20.0 (1934)
7. Gear-cutting, 'Pfauter'.	8.0 (1933)	11. Plano-milling mc.	20.0 (1934)

cont. next page..

Furthermore, the first production of a number of the most important progressive types, notably automatics and internal, surface, centreless and thread grinding machines took place at enterprises of the defence industry and there was probably some delay therefore in the diffusion of such types to all but the highest priority civilian branches.

The trend towards universalism of machines was not simply a matter of the ability, or inability, of the domestic industry to build more specialised types (although this was clearly the primary factor); other influences were at work. One factor which affected the supply situation was the distortion of the assortment which became a persistent, institutionalised phenomenon at this time, acting contrary to the demand for the production of more complex, high-productivity types. Examples of this practice are legion, but the nature of the distortion is clearly revealed by the two unusually acute cases relating to the specialised machine tool industry shown on the next page. The bias was towards the production of the simpler machines produced with the minimum labour input (*trudoemkost'*)¹ By producing the simpler machines the plan was more easily fulfilled in quantity terms and, depending on the prices of the machines concerned, was often the easiest way of maximising the gross value of output. In 1937, for example, it was reported that 'Krasnyi Proletarii' had built two ^{types of} special, high-productivity machines for producing wagon axles, each with a productivity equivalent to about twenty-five 'DIP' lathes (i.e. output of components per unit time per machine).

cont. from previous page.

12. Boring mc. (medium)	20.0 (1931)	16. Cyldrcl. grinding (med.)	22.5 (1936)
13. Planing mc. (medium)	20.0 (1932)	17. Thread-grinding mc.	24.0 (1937)
14. Surface grinding (large)	20.0 (1938)	18. Boring mc. (large)	25.0 (1935)
15. Centreless grinding mc.	20.0 (1934)	19. Planing mc. (large)	30.0 (1940)

*All '1929' built prior to the First Five-year Plan - exact date first built unknown

Source: Moizhes, Yu., "Problema razmera predpriyatiya v stankostroenii" in *Trudy Leningradskogo inzhenerno-ekonomicheskogo instituta im. V.M. Molotova*, Vyp. 3, 1947, pp. 62-63. Year first built (approx.) from Tables SA.XII&XIV and other sources.

Using these coefficients of complexity Moizhes estimates that the average complexity of the Soviet machine tool stock at the beginning of the Third Five-year Plan was 6.61, but the average complexity of Soviet-built machines during the Second Five-year Plan comprised only 5.36. Therefore, the higher level of the stock must have derived from imported machines, presumably a large contribution being made by those of 1929-33. Moizhes estimates that the average complexity during the Third Plan should have been 7.4, giving a possibility of raising the level of the stock. (*ibid*, p. 64)

But these progressive machines were removed from production on GUSIP's orders on the grounds, it was alleged, that it was better for accounting purposes to give twenty-five 'DIP's rather than one special machine.²

Plan Fulfilment and the Assortment, 1936 and 1938

Table 7.1

1. Extent of fulfilment of 1936 annual plan in first eight months (value terms)

	<u>per cent</u>		<u>per cent</u>
Drilling machines	83.0	Milling machines	52.6
Planing & shaping mcs.	79.9	Gear-cutting mcs.	50.0
Turret lathes	73.6	Autos & semi-autos	31.1
Ordinary lathes	72.1	Grinding machines	20.0
		Total GUSIP output	73.3

2. Extent of fulfilment of 1938 first half year plan (unit terms)

	<u>per cent</u>		<u>per cent</u>
Slotting machines	118.0	Gear-cutting machines	75.6
Drilling machines	112.0	Automatics and semi-autos	73.5
Ordinary lathes	103.0	Planing machines	52.4
Grinding machines	86.3	Boring machines	33.3
		Total GUSIP output	96.2

Source:

1936 - ZaInd., 27.9.1936.

1938 - Planovoe khozyaistvo, 1938, No. 9, pp. 46-47.

Thus the planning system induced a bias towards simpler machines, generally of a universal type, and hindered the production of automatics, gear-cutting machines and grinding machines, but also boring and planing machines, requiring a large input of skilled labour.

The bias towards universal equipment showed itself on the demand side as well. First there was conservatism; a distrust of new, complex equipment, coupled with an apparently widespread view that certain types of automatic and high-productivity machinery could only be employed in the large mass production auto-tractor factories. This bias was also linked with the view discussed above that all machines had to be fully utilised. It was these assumptions and prejudices against

1. See SiI, 1937, No. 12, p. 2 and Planovoe khozyaistvo, 1938, No. 9, p. 47.

2. ZaInd., 10.5.1937.

progressive equipment which were frequently assailed by Sorokin and others throughout the period, notably in 1935 when the campaign against universalism reached a high point. But the bias towards universal equipment on the part of enterprises and project offices was not simply a matter of conservatism. In capitalist countries, as Soviet writers so frequently observed, universalism of machines was induced by the need to adapt to changing market demands under the spur of competition. In the Soviet case enterprises were faced with uncertainty stemming from imperfections of planning, and also, especially from the beginning of the Second Five-year Plan period, the need to rapidly expand product ranges. Adaptability therefore became a desirable quality of the machine tool stock. This was occasionally frankly admitted by engineers when faced with criticism in the press for alleged 'fear' of high-productivity machines.¹ Possibly at this time already, but certainly later, an additional factor was strengthening the case for universalism at engineering enterprises, namely the demand for adaptability in the event of a transition to military production.²

It is difficult to determine the extent to which the price structure of domestically built machine tools influenced machine choice at the level of the enterprise in the Second Five-year Plan period and later when economic criteria of performance and khozraschet began to play a greater role. The problem was that not only were domestic prices of machine tools substantially higher than foreign, but the price differentials between machines of various types were more extreme than usual on the world market. This problem gave rise to concern from about 1934 when the Soviet industry began to produce high-productivity models. An editorial in Vestnik metallopromyshlennosti in 1935 sharply pointed to the problems caused by the Soviet price and cost differentials. For example, the '113' automatic of the im. Ordzhonikidze factory cost 10.5 times the 'TN-20' lathe; abroad the differential was only four times. "Such a gulf between the cost (and price) of complex, modern machine tools and simple machines", it concluded, "is extremely dangerous for technical progress in Soviet machine building".³ In view

1. See the case cited above, p. 256.

2. See Appendix 5.

3. Vestnik metallopromyshlennosti, 1935, No. 10, p. 5.

of the possibility of substitution for many machining operations, it pointed out, it would not be surprising if enterprises used primitive, cheap machines instead of the most advanced designs. The campaign for reducing prices which developed in 1935-36 was primarily aimed at cutting the prices of new, high-productivity machines in an effort to reduce these large differentials which were promoting a universalist bias.

In the West in the early 1930s the principle of unit-construction was eagerly adopted in the search for greater adaptability of specialised and special machine tools. In the Soviet Union the first unit-construction machine was built by the 'Stankokonstruktsiya' factory in 1934, but intensive development took place from 1935 when orders were received for machines for the auto-tractor factories. Unit-construction machines were frequently both capital and labour saving, the saving being of skilled labour because operations replaced were generally those performed on a number of complex, general-purpose type machines. An illustration of the possible savings involved is provided by the following example from 1936. For machining a housing for a vehicle gearbox two alternatives were available for achieving the desired output:

1. <u>Twenty universal machines</u>		2. <u>One unit-construction machine</u>
Cost of machines(r.)	100,000	70,000 (inc. fixtures)
Factory area (sq.m.)	100	12
No. of workers	32	2
Time per component	13.5 mins.	54 secs.

Source: Pravda, 13.9.1936.

Even at substantially less than full utilisation the more productive machine was the least cost alternative.¹

By 1937 the domestic industry had made considerable progress in the production of specialised, high-productivity machines and the structure of output had greatly improved compared with 1933, but automatics and semi-autos still represented only 2.9 per cent of total output in the specialised industry and grinding machines only 5.7 per cent. Imports rose in 1936 to above the 1933 level but fell by more than half in 1937. These imports appear to have been directed

1. See also SiI, 1943, No. 1-2, pp. 6-8.

primarily to the highest priority branches - auto-tractor building, aviation and military branches. Therefore, the structure of the new installations and the stock as a whole for many low priority, civilian branches of the engineering industry cannot have improved, or may even have deteriorated, owing to the limitations of domestic production possibilities. The forced use of lower productivity general-purpose machines for work best performed on more specialised machines must have been wasteful of both capital and labour, especially in branches characterised by mass and large-serial production. It should be noted here that the use of general-purpose machines in serial production increased in the West in the early 1930s as such machines underwent rapid technical improvement raising their productivity and simplifying their control. But in the Soviet case most of the general-purpose models in production at this time were those of pre-crisis design not really suited to the use of super-hard alloy tools. In general, as Aizenshtadt and Chikhachev admit, "The changes in the overall structure of the stock, and changes in the relationships of individual groups of machine tools, taking place in the Second Five-year Plan, were not sufficiently satisfactory".

1938 to 1941

The Third Five-year Plan years are considered separately because there were a number of unique features to the practice of selecting machine tool technology. Two new factors exerted a mounting influence; first, a general labour scarcity accompanied by an intensification of the shortage of skilled workers and, second, the demands of military production began to exert a more powerful influence on both the production and use of machine tools. But the practice of the Third Plan period was still affected by the pressures which had been active in the preceding period giving rise to bias towards universal equipment. In the summer of 1938 Gastev, in one of his last pleas for greater attention to unit-construction, noted the 'unfortunate' fact that "... enterprises on demanding the latest narrowly-special and high-productivity machine tools are forced to take more or less suitable machines or even simply universal machine tools of

1. Aizenshtadt and Chikhachev, op cit, p. 208.

obsolete designs".¹ This was echoed a year later in an editorial of Stanki i Instrument: "The growing demand for machine tools is satisfied as a rule by a quantitative increase in the output of relatively simple machine tools, sometimes at the expense of the output of high-grade, extremely necessary and first priority machines".² As before this problem must have been especially acute for civilian branches of the engineering having secondary priority.

Despite the serious supply problem there was a move towards the employment of specialised equipment in serial production branches, notably the machine tool industry itself. This policy was formulated at the First All-Union Conference of Production Engineers of the machine tool industry in 1937: multi-tool, multi-spindle, automatic and semi-automatic machines were to be introduced in large-serial machine tool building.³ Some successes were claimed, notably at 'Krasnyi Proletarii' and im. Ordzhonikidze, and a conference was held in 1938 to discuss the further development of the transfer of auto-tractor industry technology to other serial production branches.⁴

The continued shortage of specialised equipment led to a campaign during the immediate pre-war years, starting in 1937, for the modernisation and modification of the existing stock in order to raise its productivity and meet demands for scarce types. This campaign was clearly associated with attempts to reduce the demand for skilled engineering industry labour; many of the modifications were directed towards deskilling through the specialisation of general-purpose machines and the provision of features simplifying control. Examples of such modifications include the conversion of ordinary lathes into semi-automatics (it was estimated that if 15 per cent of the total lathe stock could be so converted 12,000 skilled lathe operators could be freed for alternative work),⁵ the adaptation of machines for work with hard-alloy tools, the introduction of features reducing auxiliary time,^{and} the creation of simple, operational machines from general-purpose models, e.g. lathes were converted into special boring, gear-cutting, honing, lapping and special grinding machines.⁶ A leading place in this campaign

1. Gastev, A.K., Kak nado rabotat, M., 1972, p. 450.

2. StI, 1939, No. 9, p. 3.

3. StI, 1937, No. 8, p. 4.

4. Mashinostroitel, 1938, No. 9, p. 26.

was occupied by the armaments commissariat ,NKV, which pursued a vigorous policy of modernisation and modification, fitting many machines with automatic features and simplifying others for operational work.⁷ The means of deskilling and raising the productivity of the existing stock required relatively small capital outlays; it was estimated that a 'deep' modernisation could be carried out for 20-25 per cent of the cost of a machine and a 'small' modernisation for 7-12 per cent of its cost.⁸ It could be argued that this course should have been adopted earlier, but the obstacle to its development was probably the lack of skills and experience of machine tool technology : measures securing an economy of capital and skill themselves require an input of engineering skills, which were one of the scarcest resources in the earlier stages of development.

The drive for modernisation and modification became closely associated with the campaign for multiple manning of machines, a campaign clearly promoted in response to a growing shortage of skilled workers. One of the main forms of modification of existing machines was provision of devices making it possible to operate more than one machine of a general-purpose type at a time. The lightening of control also made it possible to employ a greater proportion of women and youths as machine operators.

The trend towards deskilling was probably associated with military production demands and these demands undoubtedly exerted a more general influence on machine tool technology at this time. On the one hand a number of military branches required high-productivity machines of an adaptable nature; on the other, the need to rapidly convert civilian branches to military production must have fostered universality. Between 1937 and 1940 the number of special machine tools produced a year rose from 962 units to 6,700, and it can reasonably be assumed that many of these were required for military production. The influence of military demands on machine tool technology in the pre-War years is considered in detail in Appendix 5 .

5. *Mashinostroenie*, 16.1.1940.

6. *ibid.*, 17.1.1940.

7. *ibid.*, 9.2.1940.

8. *ibid.*, 17.1.1940.

Conclusion

We are now in a position to draw some conclusions from this review of Soviet choice of machine tool technology. The situation in 1929 from the point of view of engineering technology was in many respects a fortunate one for Soviet industry. By 1929 much experience of large-serial and mass flow production had been accumulated in both the United States and Western Europe. Machine tool technology for such production had made considerable progress: the production machine of a fairly specialised but reasonably flexible nature had been developed, the unit-construction principle had been formulated and was entering practical application, and the skill requirements of machine tools of general and specialised application were much lower than they had been before the War or in the early 1920s. Therefore, the latest, 'best' capitalist technology was indeed well-suited to Soviet requirements. Furthermore, because of the convergence of the best European, notably German, practice to that of the USA there was a possibility of obtaining suitable progressive equipment and also technical assistance from closer, better-known European markets, as well as directly from the USA. This was especially the case from the early 1930s when European firms began to build an increasing number of American-type machine tools. The development of machine tool technology during and after the crisis was also favourable to Soviet industry in so far as specialised equipment became more adaptable and the skill demands of many types of equipment were further reduced.

In the 1920s the universal machine tool predominated in Soviet engineering. During the First Five-year Plan years a determined break was made at the new enterprises of larger seriality, notably in the automobile and tractor building branches which adopted 'American' technology in almost unadapted form. Given the decision to build the auto-tractor factories of a certain capacity the choice of technology was effectively predetermined: by 1929 flow organised production using specialised equipment suited to the employment of semi-skilled workers was normal for American and European motor industry factories even of a smaller scale than adopted in the Soviet Union. To have adopted a more primitive technology and organisation, given the scale, would have been tantamount to adopting a path

involving higher costs, and much higher capital and labour, above all skilled labour, requirements per unit output. It is true that the high-productivity machines installed in the mass production factories needed skilled toolmakers, setters, repair men, etc. but a relatively small force of such workers could service many machines and during the initial period many of these functions were fulfilled by foreign workers, frequently representatives of the machine tool supplying firms. As shown in the case of the motor industry, for high priority projects involving much foreign equipment selection procedures were quite rigorous and careful account was taken of the scale of production and relevant costs.

By 1933 the Soviet machine tool industry had adopted a policy of granting high priority to the domestic production of specialised, high-productivity types of machine tools. However, in the 1930s, despite policy in favour of such equipment, a restrictive import policy coupled with domestic production limitations, and pressures stemming from the planning system, the choice procedures at the enterprise level, the demands of product changes, military production requirements, etc. tended to promote universalism in the machine tool stock. A tendency already apparent in the First Five-year Plan probably became more marked in the Second: a dualism of technology developed with, on the one hand, American-type advanced technology and organisation in the high-priority branches with access to foreign machinery and the best products of the domestic machine tool industry and, on the other, the lower priority civilian branches, which were forced to accept the low-productivity, general-purpose products of the domestic industry. The latter must have involved the use of more machines, skilled workers and factory floor area than would otherwise have been necessary, with consequent harmful economic effects in terms of lower productivity and raised costs. These trends were to some extent counteracted by measures to raise productivity and deskill the machine stock from about the mid-1930s, including the Stakhanovite movement, and the campaigns for modernisation and modification of machines and multiple manning.

Looking at the practice of the Soviet engineering industry and the products of the machine tool branch one can say that none of the policy tendencies of the

First Five-year Plan period was adopted in full. The outcome was in fact a compromise between the demands of the 'American' ,specialisation school , which did achieve considerable success, and the 'European' universalist tendency. This outcome to a large extent reflected the reality of the industrial structure which developed in the 1930s; the thoroughgoing transition to specialised large serial and mass production foreseen by Sorokin and others was not achieved. The Pankin-Zernov idea of using simple, special machines found some limited application just before and during the War, but on the whole it was not favoured: the path of very extreme operational differentiation was already being reversed in the West at the time when it was put forward. Finally, the radical proposals of Gastev had some impact, but in a much more limited form than he envisaged. Circumstances were not conducive to radical changes in technology and methods - time was against experimentation. By 1941 there was little place for radical visions of the type put forward by Gastev, Perel'man and others in the First Five-year Plan, when it was widely believed that there was no task beyond the Bolsheviks given the will : the experience of the 1930s promoted a more sober assessment of technology and the conditions of its use.

Chapter 8SOME ASPECTS OF TECHNICAL PROGRESS IN THE MACHINE TOOL INDUSTRY

By 1929 the Soviet Communist Party and government was committed to a policy of as rapidly as possible 'catching up and surpassing the advanced capitalist countries both technically and economically' and, as a means of achieving this aim, to the use of the latest, most advanced, technology of the capitalist world. The aim and means, and the situation of the Soviet economy of the period, make it essential that any analysis of the technical development of the economy as a whole, or of particular branches, be situated within the context of the interaction of two different and mutually opposed social and economic systems. The rate and directions of technical development in the capitalist countries exerted a profound influence on Soviet economic development, just as certain aspects of technical and economic progress in the Soviet Union had a reciprocal influence on the West. More concretely, Soviet industrialisation effectively began at a time when the capitalist economies were entering the most serious economic crisis yet experienced; a crisis the duration of which coincided in time with the First Five-year Plan. The Second Five-year Plan took place at a time when the capitalist economies were passing through a post-crisis depression, followed by a limited revival. The fact that the crisis exerted an influence on Soviet trade possibilities is often acknowledged, but another important aspect - the extent and nature of technical progress in the capitalist economies during and after the crisis and its influence on Soviet development - has not been considered in the literature. The first part of this chapter is devoted to a consideration of the rate and directions of technical progress in the machine tool industries of the major producing countries from the late 'twenties, Soviet perception of this progress and responses to it. In the second part, some aspects of technical innovation, its institutions and mechanisms, in the Soviet machine tool industry of the period are discussed in the light of the preceding analysis of technical progress in the West.

1. The Capitalist Crisis and Technical Progress in the Machine Tool Industry

Before considering the Soviet perception of the impact of the crisis on technical development in the machine tool industry it is necessary to briefly look at the broader question of Marxist analyses of technical progress in general under the conditions of capitalism at its monopoly stage. Under the conditions of pre-monopoly capitalism, as Marx had shown, the main driving force of technical progress was seen as competition between capitals both on the domestic and world markets. With the development of monopoly, assessments of the possibility of technical progress hinged around the question of the degree to which competition remained an essential characteristic of the capitalist system. The classic analysis of imperialism presented by Lenin indicated clearly the contradictory impact of monopolisation on technical progress. On the one hand, the growth of monopoly gave rise to a tendency to decay and stagnation with restriction on competition, monopoly pricing and the possibility of artificially hindering the introduction of technical novelties. But, Lenin stressed, monopoly could not for long suppress competition: "...the possibility of lowering costs of production and raising profits by means of introducing technical improvements acts to the benefit of change. But the tendency to stagnation and decay characteristic of monopoly continue to act and in individual branches of industry, in certain countries, for certain periods of time, it gets the upper hand".¹ Thus while there was a tendency to stagnation and, as an expression of this, to the holding back of technical progress, Lenin warned against the absolutisation of this aspect: competition remained, and intensified during crises, giving the possibility at times of very rapid technical development.

Lenin's analysis of monopoly capital and technical progress was that held in the 1920s by most economists; despite the prevalence of monopoly and the onset of the 'general crisis of capitalism' widescale technical progress continued.²

1. Lenin, V.I., Polnoe sobranie sochinenie, 5th edn., Vol. 27, p. 397.

2. See, for example, Varga, E., Sovremennyi kapitalizm i ekonomicheskie krizisy, M., 1963, pp. 80; 92-100.

Those to the Left of the Party (Trotsky, Preobrazhensky) tended to have a more negative assessment of the possibility of further development of the productive forces and placed greater emphasis on monopolistic restriction of technical progress.¹ To the Right, Bukharin placed greater emphasis on the rapidity and wide scope of technical change under imperialism before the crisis.²

With the onset of the crisis, in the years 1929 to 1932, there appears to have been a widely prevalent view that technical progress had been, if not halted, then greatly curtailed. This is not easy to document because reference to technical progress in the capitalist countries during these years are rarely met. (The speeches of Stalin and other Party leaders stress the unprecedented depth and scope of the crisis but make no reference to the fate of technical progress). There are some indications, however, of the generally held view.

Bukharin, at the time the head of the Scientific Research Sector of VSNKh (later NKTP) and one of the most prolific writers on questions of science and technology during the First Five-year Plan, on a number of occasions stressed that the crisis was leading not to technical advance, but regression. Thus:

"Formerly crises gave an impetus to technique to a certain extent; the most technically progressive enterprises adopted new improvements, lowered their costs, extricated themselves out of the crisis, competed with other enterprises and made differential profits. The other enterprises had to catch up with them, to reach their level and so on. Now a different tendency can be observed: a slackening of technical progress. This is due to the far reaching development of the monopolist character of the structure of contemporary capitalism, to the extraordinary depth of the crisis and the absence of any clear prospect of future improvement. This practice and theory of technical regression began to flourish towards the end of the period of so-called 'industrial prosperity'... Thus the contradictions of present-day decaying capitalism are undergoing a tremendous strain; its technical shell is still moving forward, but it already wears iron fetters; further progress is already outside the groove of capitalist relations".³

That this was a general view is supported by evidence from the machine tool industry itself. Writing at the end of 1931 Al'perovich observed that: "In conditions of the crisis, when basic users of machine tools obviously do not

1. The following is typical of Trotsky: "...after the War...one can speak only of making good the destruction, but certainly not of the further development of the productive forces" (*Evropa i Amerika*, M., 1926, p.8 cited by Roginskii, G., *Zakat kapitalizma v trotskistkom zerkale*, M., 1932, p.15). Preobrazhenskii held that 'monopolism' led to the curtailment of accumulation and the 'thrombosis' of the productive forces, including technology. (see *Zakat kapitalizma*, M., 1931)

intend to purchase any new machines,...the striving of machine tool builders to create new machines disappears as well".⁴ Similarly, Sokolov, in a popular work on the machine tool industry published in 1932, confidently asserted that: "The gigantic socialist construction taking place here is accompanied by a remoulding of people on a new technical and socio-economic basis, whereas for them (the capitalist countries -JC) economic development hits rock bottom and technology freezes and goes into reverse".⁵

Further confirmation that the prevailing view during the period 1929 to 1932 was that the crisis curtailed technical development is provided by later contributions which specifically made the point that, despite a general tendency to stagnation, in fact technical progress had continued. One of the first such tentative acknowledgements came at the end of 1933 (i.e. after the low point of the crisis) when Leikin, after first observing that the crisis had greatly intensified the tendency to technical stagnation, proceeded to analyse the directions of technical progress which had in fact occurred - introduction of new materials, changes leading to the intensification of production processes, the development of flexible means of production adapted to the current limited scale of output and the possible future expansion. Above all, Leikin stressed that the technology of weapons and their production had been the main element of technical progress. This led him to conclude that: "The crisis has not halted technical development ...the Trotskyist notion of the stagnation and 'thrombosis' of the productive forces has been refuted yet again".⁶ From this time on acknowledgement that technical progress had not halted became more and more frequent in the Soviet press, although ⁱⁿ one of the most authoritative works of the period on technical policy published in 1934 E. Granovskii still asserted that: "The technical regress of capitalism in the period of the present day crisis is a most vivid illustration of the retarding influence of crises on the development of technology".⁷

2. See, for example, Bukharin, N.I., "Tekhnika i ekonomika sovremennoy kapitalizma", in *Etyudy*, M.-L., 1932, especially pp. 84-95.

3. Bukharin, N.I., *Socialist reconstruction and the struggle for technique*, M., 1932, pp. 8-10 (in English) (based on a speech of August 1931).

4. *SI*, 1931, No. 11-12, p. 1.

5. Sokolov, A., *Sovetskoye stankostroyeniye*, M., 1932, p. 6.

6. *Za Ind.*, 7.11.33.

As Bukharin had observed, the general view of economic crises held by Marxists was that, with the intensification of competition which took place as firms strived to extricate themselves from disaster, new technical means would be created and introduced in the hope of cutting costs and securing increased profits. In the initial period of the crisis technical development may indeed slow down (and probably did in the years 1930-31), and to this extent Bukharin and others were correct in their assessment; but where they were wrong was in absolutising this technical slowdown and in seeing no possibility of a further renewal, or even intensification, of development. This overestimation of the depth and seriousness of the crisis, coupled with an underestimation of the possibilities of a capitalist solution to it being found, is understandable in the light of its unprecedented severity and the prevailing expectations of a revolutionary solution to the contradictions of the system, but it was to have repercussions for Soviet technical policy.

A further related mistaken assumption appears to have had wide currency at the time of the First Five-year Plan and the early part of the Second. Stemming from the above mentioned assessment of the prospects of technical development under capitalism, the slogan 'catch up and surpass' tended to be interpreted in the sense that the Soviet Union had to catch up and surpass a given, relatively stable level of technical-economic development: the crisis gave rise to an illusion that the target was static. This led to the view that Soviet industry simply had to build new factories at the level of the best available capitalist technology (of 1929) and assimilate the production of the latest products and, having successfully achieved this, proceed to surpass the capitalist countries by building its own newer factories and producing its own newer products. During the time of the First Five-year Plan, in the face of immense difficulties and demands for great sacrifices, and with the capitalist countries in crisis as a backcloth, this was an understandable and reassuring illusion. Again, evidence for this phenomenon is indirect, notably in the many later statements, appeals and explanations to the effect that 'catching up and

7. *Tekhnicheskaya rekonstruktsiya v pervoi pyatiletke*, M.-L., 1934, p.16.
 1. cf., Lenin, *op cit*, Vol.24, p.369.

surpassing' involved pursuit of a moving target. This static approach to the capitalist technical level appears to have been strongest in the early 1930s when the first successes of assimilating modern technology had been achieved. As will be shown, it was not easy to keep up pressure for further effort to push technology to a still higher level.

Soviet Recognition and Response to Technical Change in Machine Tool Building

The first frank admissions that the crisis had promoted intensive technical development in the machine tool industry came in 1934. Prior to this there were a number of hints that technical development had continued, but its scope and intensity were not recognised. Levin, director of ENIMS, reviewing the 1933 Leipzig Exhibition, noted that the crisis had cut the number of exhibitors and that there were no new design ideas.¹ However, improvements were noted - reduction of machining time, centralisation of control, raised precision and the use of hydraulic drive mechanisms.¹ Similarly, Leikin in his above mentioned review of technical developments, noted that there had been successes in the use of hydraulic drives and features securing the flexible application of machine tools.² In May 1934 a controversy broke out over the type of radial drilling machine to be built at the new Khar'kov factory: for the first time the practice of copying models of 1929 was challenged and the right to design more modern original machines demanded.³ But it was M. Orentlikher, head of the machine tool section in the 1920s and in 1934 an engineer of the technical-production sector of NKTP, who first really alerted the machine tool industry to the seriousness of the new situation and the falseness of previously held conception. Noting the sharp cut back in production and the despecialisation of factories which had occurred during the Depression, Orentlikher continued:

"It would however be incorrect to think that the crisis of capitalism has entailed a full cessation of the development and improvement of machine tool design. Some foreign engineers, characterising the present-day state of machine tool building, contrast the action of the crisis to an unpleasant medicine, which, despite its extremely unsavoury taste, brings about some positive results. What positive results has the crisis brought about in the

1. *SI*, 1933, No. 5, p. 13.

2. *ZaInd.*, 7.11.33.

opinion of these foreign engineers? It induces technical workers to exert themselves to the utmost to seek methods of weakening the impact of the low utilisation of the productive apparatus and of the growth of costs of production. Despite the extraordinary cutback in outlays on experimental work extremely productive machines have been designed in recent times, improvements in production technology have been achieved, etc. As a consequence of these improvements, machine tools profitable as recently as 1929-30 have by now already become out of date. The extreme intensification of competition induces continuous improvement of machine tool design".⁴

The main directions of technical progress identified by Orentlikher were the use of hard alloy tools, leading to increases of the speed of machines and the use of more rigid fixtures, reduction of leading times with the use of hydraulic and electric chucks, the very rapid introduction of hydraulics, the replacement of milling and planing by broaching, and the design of machine tools for use with new light metals and alloys finding increasing application in the motor industry.⁵ Thus, Orentlikher concluded, technical thought had moved forward in the years of the crisis; the Soviet industry would have to rigorously study these changes and critically assess them in determining its technical policy. One point in Orentlikher's account may have been inaccurate if another Soviet expert writing at about the same time is to be believed. Piterov, head of Orgametall, writing during a visit to the USA, reported that at all the machine tool factories visited the design staff had been retained, or even strengthened, despite the crisis.⁶ Thus outlays on experimental work may not have been cutback quite as sharply as Orentlikher suggested.

The implications of Orentlikher's article were disturbing for Soviet industry. All the new models which had been introduced in the previous five years as examples of the very latest capitalist technology, and were still being introduced in 1934, were those of 1929-30 or earlier and, furthermore, a large proportion of the machine tools imported at such a great cost during the Five-year Plan were now, it appeared, out of date. In November 1934 Orentlikher

3. This controversy is discussed below, p. 322.

4. Plan. Khoz., 1934, No. 8-9, p. 22. Emphasis added.

5. Ibid., pp. 22-27.

6. Za Ind., 23.6.34.

restated his case in a further article drawing attention to the role of new super-hard alloy tools in transforming machine tool design: the "iron laws of competition" were, he believed, forcing a switch to the new tools and hence new machine tools adapted to their use, whether this change was desired or not.¹ From subsequent events it seems that many in Soviet industry did not at this time take Orentlikher's assessment very seriously.

In the autumn of 1934 a number of the leaders of the machine tool industry, including Kaganovich, Al'perovich, Levin and Vannikov (Tula arms factory) had the opportunity to see for themselves at the London Machine Tool Exhibition. This experience made a great impression on the Soviet visitors. At the Seventh Congress of Soviets early in the following year, Kaganovich related how when the Soviet engineers first looked at the exhibition they at once decided that there was nothing to be learnt. He, Kaganovich, had then told them not to be 'dilettantes' and to study a few exhibits in great depth; they had done this and, as a result, had concluded that the Soviet industry was lagging behind. This, Kaganovich declared, showed how correct and timely had been Stalin's warning to workers of the metallurgical industry that they must not become 'swollen headed' with their achievements.² What were the developments revealed by the London exhibition? First, it was evident that the British machine tool industry had made very rapid progress during the previous four-five years, and that an important role had been played by allied branches, notably suppliers of electrical and hydraulic equipment.³ Second, the speed of cutting had risen very sharply with the adoption of hard alloy tools, e.g. a lathe with a maximum speed of 3,000 r.p.m. was shown (the DIP lathe had a maximum speed of 600 r.p.m.), and a small turret lathe of 4,000 r.p.m. (compared with 600 r.p.m. of the im. Ordzhonikidze factory's '136')⁴. Third, very rapid developments had taken place in the use of hydraulics, assimilation of which was only beginning in the USSR in 1934. Other developments included the simplification of control, automatic gauging, the use of electric

1. Vestnik metallopromyshlennosti, 1934, No. 11, p. 61.

2. 7 s"ezd Sovetov, M., 1935, Byulleten' No. 10, p. 45.

3. ZaInd., 30.11.34; 6.1.35.

4. 7 s"ezd Sovetov, op cit., p. 46.

motors fully integrated into the machines, and the use of roller bearings.

Kaganovich concluded from this experience that there was still a very great deal of work to be undertaken before the task of catching up and surpassing could be realised. Measures had to be adopted to meet the challenge: there were still very powerful forces promoting technical development: "In capitalist countries competition and the striving to pull out of the crisis and hold a position on the market at times force the large enterprises to enormous risks in the search for new designs, giving rise to thoroughgoing technical revolutions in the branches of industry served by the machine tool industry".¹ Two recommendations were made. First, in order to secure rapid technical development a major strengthening of experimental work was an essential first priority²; second, the role of the designer had to be greatly enhanced.³ This theme was taken up by Ordzhonikidze in his speech to the Congress of Soviets, when he drew general lessons for the Soviet engineering industry:

"The designs of machines must be continuously improved. We must take all the best examples of American and European technology and adapt them to our needs, and then it is necessary to boldly improve them. Here the greatest danger is to become rooted to the spot. Hence the enormous role of the designer... Our machine builders have still not yet sufficiently developed a taste for new designs and new machines, for the improvement of mechanisms, and without this lagging behind and stagnation are inevitable. A most resolute struggle must be waged against such conservatism".⁴

The Seventh Congress of Soviets in January-February 1935 is significant as the first major public occasion at which the possibility of Soviet industry technically falling behind the capitalist countries was raised, and the essential task posed of not only assimilating the best capitalist technology, but further raising its level.

The machine tool industry was immediately affected: NKTP, presumably at Kaganovich's instigation, issued an order at the beginning of 1935 calling for the introduction of new models to replace basic models first produced less than

1. *Bol'shevik*, 1935, No. 6, p. 17. (Kaganovich)

2. *Za Ind.*, 6.1.35 (Kaganovich and Al'perovich)

3. *7 s"ezd sovetov*, op cit, p. 46.

4. Ordzhonikidze, G.K., *Stat'i i rechi*, M., 1957, Vol. 2, pp. 642-643.

three years before. 'Krasnyi Proletarii' was to master a new lathe of its own design with a speed of up to 3,000 r.p.m., and im.Ordzhonikidze was to replace its turret lathe by a new machine with a maximum speed of 1,500 r.p.m.¹ This order has all the signs of a panic measure, and was to cause serious problems for the 'Krasnyi Proletarii' factory; later, as we shall see, it was to be criticised. Reporting on the Third Conference of Designers in March 1935, Peshkin wrote that even 'Krasnyi Proletarii' workers themselves would admit that the 'DIP' lathe had 'outlived its age' and needed to be replaced by a fundamentally new design.² Presumably it was felt that the lag was so great that modernisation of existing models would prove inadequate.

Criticism of ENIMS and the glavk leadership for its technical policy mounted in the summer of 1935, it being widely felt that they were not responding adequately to the demands of accelerating technical progress. Shaumyan and Agapov, for example, charged that ENIMS was taking the path of least resistance by still recommending for production foreign models of 1925-29.³ The lag of the industry was the main topic of the branch's Party-technical conference in July,⁴ and shortly after this NKTP issued a major order on the role of designers in the engineering industry, which outlined measures for tackling the task of securing further design improvements in already produced machines.⁵

Accounts of the rapidity of technical change in the West, coupled with sharp criticisms of complacency in the Soviet industry continued in the autumn of 1935. Kaganovich returned to the lessons of the London exhibition and wrote of a lag of 'several years' in Soviet designs⁶, while Al'perovich, Sorokin and others had an opportunity to see the latest American machines at the Cleveland Exhibition and a number of American machine tool works.⁷ This experience seems to have strengthened the position of those demanding action. Thus, "Visits to the USA and other countries by our aircraft, motor and machine tool builders have shown

1. *Istoriya SSSR*, 1957, No. 2, p. 49.

2. *ZaInd.*, 22.3.35.

3. *Izvestiya*, 5.7.35.

4. *ZaInd.*, 15.7.35.

5. *Ibid.*, 18.7.35.

6. *Ibid.*, 1.8.35.

7. *ZaInd.*, 23.10.35.

how intensively Soviet machine tool builders must work in order not to fall behind...A significant number of branches of engineering in the capitalist countries made great strides during the crisis".¹ Bashta, the leading hydraulics expert of the branch and deputy editor of Stanki i instrument, attacked illusions held by a section of workers in the industry: "The widespread opinion held by this group that we have already 'caught up', and that we have even 'surpassed' other countries in the realm of machine tool building, is harmful conceit".² Clearly, there were many in the industry who believed that having taken a leap from the technology and methods of the nineteenth century to those of modern America and Europe efforts could be relaxed and gains consolidated at this new technical level. The Party, NKTP and the industry's leadership, recognising the considerable technical development occurring in the capitalist countries kept up the pressure for change, however, and posed ever more complex tasks for solution.

The attempt to abruptly change the models built by the leading factories ran into difficulties and this seems to have led to some reconsideration of methods of securing technical development. The Fourth Conference of Designers in April 1936 devoted considerable attention to the modernisation of existing models as a central element of technical policy. The resolutions of the conference also outlined measures for the promotion of experimental work as a vital component of the modernisation effort.³

The danger of falling behind the technical development of the capitalist countries was a central theme of the speeches of a number of leading NKTP workers at the Soviet of NKTP in May-June 1936. Pudalov criticised 'responsible workers in heavy industry and in particular machine building', who in the press and in public speeches declared that the Americans had been surpassed and overcome. This, he stressed, was harmful self-deception, for, "The capitalist countries do not wait, and will not wait, for us to catch up with them. They are going forward, conquering ever newer technical positions, and this imposes a very great deal upon us".⁴ Rukhimovich, deputy NarKom, went further - he listed a number of branches

1. Vestnik metallopromyshlennost, 1935, No. 10, p. 3 Editorial (editor then A.D. Pudalov).

2. SI, 1935, No. 10, p. 6.

3. SI, 1936, No. 6, pp. 1-3.

4. Sovet pri NKTP SSSR, 25-29 iyunya 1936g. (Sten. otchet.), M., 1936, p. 153.

in which, compared with a few years earlier, Soviet industry had, he believed, fallen behind; these included the auto-tractor, power equipment, measuring instruments and turbine building branches.¹ This same point was stressed by Ordzhonikidze : "From month to month ~~to month~~, from year to year we must raise out technology and our industry to ever greater and greater heights. If we do not have this perspective before us all the time we may come to a halt on one good engine.. a good tractor, or blooming mill.. and stick fast to them. But technology ..advances all the time and he who lingers even for a moment on the path of advance falls behind".² Thus we have a picture of Soviet industry having pulled itself up to a modern level and freed itself from the threat of subjugation to the world capitalist market , being subjected to a new source of external pressure over which it had very little control : the pressure of rapid technical development driven forward by the forces of competition and an arms race fueled to a great extent by hostility to the Soviet Union itself. This external military threat made it impossible for the Soviet Party and government to ignore the pressure of technical advance , in particular in those sectors directly and indirectly related to armaments production (a large proportion of the modern economies of the 'thirties) and forced them to seek mechanisms for promoting independent technical development or, at least, for mitigating the consequences of the possession of a lower level of technology where this was the case. In this perspective the Stakhanovite movement, coinciding in time with this concern for the maintenance of technical advance, can be seen as a bold attempt to harness mass enthusiasm to the task of catching up and surpassing the forward moving technology of the capitalist world.

At the Soviet of NKTP the machine tool industry was not singled out as a later case of 'falling behind', but in a number of contribution/in 1936 and in 1937 it was clear that some specialists did think that this was then happening. Telyatnikov, in a thorough and well-informed review of recent technical developments in machine tool building, expressed the view that there was no other branch which had experienced such rapid progress in recent years: work on design

1. *ibid*, p.202.

2. Ordzhonikidze, G.K, *op cit*, p.668.

improvement intensified during the crisis. The technical changes in the West had not been reflected to a sufficient degree in Soviet machines, he stressed, "... the basic part of the machine tools we make still refer to those types which we copied from the best foreign models four to five years ago and even earlier, but which are now already old fashioned"¹. The experienced engineer, Satel', also considered that the latest machine tools were fundamentally different from those produced prior to 1933-34 and concluded that, "In machine tool building we lag from America and partially from Germany by 5-10 years. This can be said, incidentally, of many other spheres of our machine building".²

A useful review of some of the painfully learnt lessons of the struggle for industrialisation was presented by a leading Soviet specialist on science, technology and the economy, M. Rubinshtein, in the autumn of 1937. "The task of catching up and surpassing the technical and economic level of the advanced capitalist countries", he wrote, "does not at all mean the achievement of some kind of immobile target. This target itself is dynamic. Despite the general crisis of capitalism the economies of the capitalist countries are not at all in a state of total stagnation... Despite all the decay of capitalism technology does not stand still. Thus in this contest of two worlds, which is expressed in the slogan 'catch up and surpass', capitalism does not surrender a single position without a fight, and with all the successes of our rapid assault on this front, we still have not a few lagging sectors".³

The question naturally arises; did technology in the machine tool industry in the capitalist countries advance during and after the crisis in the manner described by Soviet industrial leaders, planners and technical specialists? Or was the external technical progress invoked as a whip to drive on Soviet industry? There is no doubt that drawing attention to external pressure and threats was a means of mobilising mass activity, but the contemporary evidence of Western specialist, presented in the following section, lends support to the view that this external pressure of technical progress was a very real phenomenon.

1. Problemy ekonomiki, 1936, No. 4, p. 52.

2. Za Ind., 27.8.36.

3. Bol'shevik, 1937, No. 21, p. 70.

The Development of Machine Tool Technology , 1929 - 1941

Although generally derived from empirical observation alone, without any theoretical analysis, accounts of the nature of technical development of the machine tool industry during periods of depression and crisis presented by Western machine tool builders and academics reach conclusions similar to those provided by orthodox Marxist theory. The following statements by leading American machine tool building specialists summarise the prevailing view in the 'twenties and 'thirties:

"The history of every depression shows that precisely in such times are improvements mostly made in designs. This is perfectly natural for two reasons: first, because the machine tool builder has more time to think in periods of that sort, when the pressure of production is relieved, and second, because the pressure of competition and the necessity of getting business drives him to coax every possible bit of business his way by bringing out newer and better machines"

E.F.DuBruhl, National Machine Tool Builders Association, USA, 1922.¹

"In periods of low production the skilled designers, engineers and mechanics of the machine tool industry are kept at work on improvements in machines that time does not permit when work is being done under high pressure to meet delivery demands"

H.Lind, National Machine Tool Builders Association, USA, 1936.²

This view is supported by Wagoner, the historian of the American industry: efforts to improve machine tools tended to vary inversely with current demand for existing machines,³ while W.Brown, in one of the few economic analyses of innovation in the machine tool industry, also concluded that innovation occurred when demand fell.⁴

Given this unanimity on the general dynamics of innovation in the industry, did this relationship hold in the acute conditions during the Depression, and was the technical progress of the period notable in any respect? The crisis had a very great impact on the machine tool branch. Taking 1929 as 100, new

1. American machinist, Vol 57, 1922, Aug., p. 205.

2. Mechanical engineering, 1936, Jan., p. 23.

3. Wagoner, *op cit*, pp. 28-30.

4. Brown, W., "Innovation in the machine tool industry", Quarterly journal of economics, Vol. 71, 1957, pp. 406-425.

orders for machine tools in the USA reached a peak of 142.0 in February 1929 and plunged to a low point of 8.3 in March 1933. For Germany the high point was attained in June 1929, at 114.7, and the lowest point of 31.0 in January 1933¹. (The smaller fall in the case of Germany can to a very great extent be explained by the impact of Soviet orders). According to research by Brown the forty leading US companies shipped machines to a total value of \$333 million in 1928 and 1929; but only \$73 million in 1931 and 1932. Yet in the two years of deepest crisis these firms introduced a total of 74 new models, compared with 53 in the last two years of 'prosperity'.² Undoubtedly some firms adopted a 'wait out the storm' policy, but, as Piterov discovered in 1934, many large firms quite deliberately maintained their design forces, or even increased them. Cincinnati, for example, pursued a vigorous development programme during the crisis years: during the Depression important new vertical boring and cutter grinding models were launched and a new factory established in Britain.³ It is possible that in the German case innovative activity was somewhat less vigorous, if comments by Soviet specialists are correct, but in the case of Britain there is little doubt that progress during the crisis was more rapid than in the period preceding it. A leading British specialist, writing at the end of 1930, observed that: "British tool makers, with a few noteworthy exceptions, are where they were ten years ago, and have made little progress. More change has taken place in the last twelve months than in the previous ten years".⁴ As noted above, the striking changes in British machine tools greatly impressed Soviet experts in 1934.

Turning to the qualitative aspect of technical progress during the crisis, can the extent and directions of technical change after 1929 be determined? During the 1920s machine tool design for basic general-purpose machines only gradually improved; major technical developments occurred more in the sphere of

1. *Problemy ekonomiki*, 1935, No. 4, p. 128. This article by M. Rozman and the later book (1940) by the same author are probably the best studies available on the impact of the crisis on technical progress in the capitalist countries.

2. Brown, *op cit*, p. 414.

3. *Men of purpose*, Cincinnati, 1964, pp. 20-21.

4. Armitage, H.C., *Institution of Automobile Engineers, Proceedings, 1930-31, Dec. 1930*, p. 196.

special machines. Writing at the beginning of 1936 an American engineer, Hubbard, noted the 'conservatism' of most machine tools of 1929. A typical 1929 machine had a motor and belt drive (although the design was still basically that appropriate to belt drive from an overhead shaft), plain bearings, primitive lubrication, mechanical control by levers and knobs, and could be used with high-speed steel tools but little more. Pneumatic and hydraulic devices, if available, were generally extras. Many designs of this time were based on improvements generated during the depression of 1920-21.¹ Despite the depression, as Hubbard proceeded to demonstrate, there had been what he termed a 'Five year revolution in machine tool design', reaching its climax in 1935, the year of the Cleveland Exhibition. Individual elements of this 'revolution' were known and in use to a limited extent before the onset of the crisis. The primary element was the introduction in 1927 of extra-hard, wolfram-carbide alloy tools, marketed under various names, e.g. 'Carboloy' in the USA, 'Widia' in Germany, and later, 'Pobedit' in the USSR. The previous major tool developments had been high-speed steel at the turn of the century (replacing carbon steel) and, in 1907, a high-speed cutting alloy, stellite. A second element was the individual electric motor used as a power source; a third was the hydraulic drive unit, first employed to drive the table of a milling machine in 1927. A fourth advance applied in 1929, albeit in a primitive form was the unit-construction principle of building machine tools, giving the possibility of making more flexible special machines.

The crisis posed certain economic demands on technology, stemming from the necessity for capital of counteracting the falling profit rate in circumstances of considerable unutilised capacity and a greatly diminished market. The difficult financial situation precluded the introduction of new technology requiring large or risky capital investment, and for this reason radical innovations founded on new technological principles were few. The main thrust of

1. Iron age, 2.1.36, p.221.

innovative effort was directed towards cutting costs of production by intensifying work, at the same time, in order to maximise the utilisation of equipment still in operation, efforts were directed towards flexibility of machine tools, adapting them to low production runs without jeopardising the possibility of efficiently employing them when the economic situation improved. The main paths of fulfilling the demand for the intensification of work were, firstly, raising the speed of direct machining by employing the new super-hard alloy tools and fully adapting machines to their use; second, by reducing the auxiliary time, the proportion of which in total working time rose as machining time was cut; third, by deskilling the use of machine tools, by simplifying and lightening their control. Flexibility in terms of adaptability to different types of workpieces and scales of output was achieved by the provision of wide speed and feed ranges, the use of fixtures and, for more specialised, high-productivity machines, the adoption and development of the unit-construction principle. Finally, a strong influence on design was exerted by new military-related demands posed, in particular, by the aircraft industry, which demanded machine tools suitable for machining light metals and alloys (magnesium, aluminium, duralium, etc.) Such machines had to secure a light cut at very high speeds.

During and after the crisis these elements were combined to create new machine tools in many respects different from the 'conservative' types of 1929. Redesign for the use of new tools involved a major reassessment of past practice, and as part of this change machines were for the first time built specifically for the use of individual electric motors which became an integral part of the design. In order to provide the necessary higher speeds, the power of the motors had to be raised, the rigidity of the machines greatly enhanced, ball and roller bearings replaced the previous plain bearings, and centralised, forced lubrication systems had to be employed. The demands of greater rigidity, coupled with the need to reduce auxiliary time, led to the wide use of pneumatic and other quick-action chucks and work-holding devices. Auxiliary time was also reduced by improving speed selection, and the stopping and starting of machines and, on some models, in particular grinders, automatic gauging was introduced, securing work of high

accuracy with a minimum disruption of the work process. Smooth operation, ease of control and reduced idle movements were secured by the use of hydraulic drive units. Machine tool electrification made great strides during the crisis, allowing the centralisation, lightening and simplification of control. Push button starters were widely diffused. These developments in the sphere of control permitted the use of less skilled labour, while lightening control allowed the wider employment of female and young workers. Furthermore, the development of automatic control allowed the development of multiple machine manning with consequent labour cost savings. Many of the outlined changes were introduced on general-purpose types and had the result that their productivity and scope of operation were increased permitting their profitable employment in circumstances formerly appropriate only to the use of more specialised production equipment. With the revival of the motor industry there was extremely rapid development of unit-construction type special machines and the introduction of transfer lines for machining cylinder blocks and other large components. Finally, during the crisis and after new methods of machining were further developed and found quite wide application from the mid-1930s. These included surface and external broaching, honing, lapping, diamond boring, and new gear-cutting techniques. While these changes did not perhaps amount to a 'revolution', they nevertheless added up to a major step forward in machine tool design which effectively rendered the products of 1929 obsolete.¹

Rapid technical development was maintained in the second half of the 1930s, although significantly it was reported early in 1937, when demand in the USA temporarily exceeded the 1929 level, that, "The past year has not been signalised by any outstanding developments in the machine tool field, mainly owing to the high pressure of production experienced during the period".² The demands of military production began to exert a mounting influence, leading to further automation in order to facilitate deskilling, the creation of new high-speed, high-productivity lathes and turret lathes, and promotion of precision machine tool building.

1. Machine tool technical developments of the period are described in: Iron age, 4.1.34; 2.1.36; Machinery, 16.11.33, pp.202-203; 3.10.35, pp.26-30; Problemy ekonomiki, 1935, No.4, pp.128-138; ibid, 1936, No.4, pp.51-58.

2. Mechanical engineering, 1937, Jan., p.137.

In conclusion, it is clear from the above review that the leadership of the Soviet machine tool industry had real grounds for concern in the mid-1930s about the technical progress which had taken place in the industry in the capitalist countries during and after the economic crisis. The Soviet machine tool industry was indeed faced with catching up a quickly moving target in the pre-War years.

2. The Evolution of Institutions and Mechanisms for Research, Development and Innovation

During the First Five-year Plan period the Soviet machine tool industry was faced with the task of fundamentally renewing its product range, replacing models dating from before the War and the early 'twenties by new models at the level of the best world machine tool technology. During the 1930s the product range was rapidly expanded with types previously not built in the USSR and, at the same time, as shown above, it was found necessary to replace and modernise models assimilated in the recent past. Therefore, throughout the period the question of technical innovation was a central concern of the branch. The leadership of the industry was forced to devise a structure of institutions and procedures appropriate to the conditions of the socialist planned economy for realising the introduction of new models and developing an independent innovative capacity. Some aspects of this problem are considered in this section.

The Evolution of the R.&D. Institutional Framework

Before the Revolution some very limited research into the theory and practice of metal cutting technology was undertaken at polytechnical institutes in Moscow and St. Petersburg, where courses on metal cutting were offered. Notable figures involved in this work were A.P. Gavrilenko, A.D. Gattsuk and N.N. Savvin.¹ After the Revolution there was little interest in research into machine building until 1927, when a group of prominent engineering industry specialists, including

1. See *Izvestiya vysshikh uchebnykh zavedenii - mashinostroenie*, 1967, No. 10, pp. 119-122; and Aizenshtadt and Chikhachev, *op cit*, pp. 123-136. Note - Savvin was the first in world machine tool building practice to draw up acceptance standards for metal-cutting machines (in 1913) - *ibid*, p. 136.

N.F.Charnovskii, A.S.Britkin and S.S.Chetverikov called for the establishment of a specialised research body. This was created and started work in 1928 as the Moscow filial of the Institute of Metals, and in January 1930 gained independence as the Institute of Machine Building and Metalworking (NIIMash) under Mashinoob"edinenie, VSNKh. In 1930 this institute was undertaking research into methods of testing machine tools and studying the quality of domestically built products.¹ NIIMash remained the leading engineering research institute throughout the 1930s and undertook some work on machine tools and metal cutting. Also in the late 1920s the Orgametall demonstration hall undertook comparative testing and study of foreign machine tools in order to investigate their suitability for use in Soviet industry.²

The idea of creating a specialised R.&D. base for the machine tool industry arose for the first time in 1930. In the first issue of Stanki i Instrument in August Pankin called for the concentration of the design forces of the branch in a single centre and the creation of a council to oversee the work of this design office and an investigations office. In a comment on these proposals Al'perovich put forward the view that the task of the central design office should be to work out the general design 'schema' of machine tools, leaving the factory design offices to prepare working drawings.³ Also early in August 1930 Al'perovich called for the creation in 1930-31 of a 'factory of new designs' in the form of an experimental base for the elaboration and building of first examples of new designs on the basis of the latest achievements of world technology.⁴ In September 1930 these demands were incorporated in a VSNKh order on the machine tool industry: a special research institute and central design office (hereafter TsKB - tsentral'noe konstruktorskoe byuro po stankostroeniyu) were to be created within the structure of Stankoob"edinenie, the latter to have an attached factory of new designs.⁵ This was a bold and imaginative project for the time, having

1. SI, 1930, No. 1-2, p. 7; No. 3-4, p. 4.

2. 10 let Orgametalla, 1924-34, op cit, pp. 29-30.

3. SI, 1930, No. 1-2, p. 5.

4. Izvestiya, 9.8.30.

5. Za+nd., 17.9.30.

no equivalent in world practice. In Germany machine tool research was well-developed but took place almost entirely in the higher educational sector, while in the United States research was generally less developed. Neither branch research institutes, nor experimental factories for the production of prototypes existed at this time in other machine tool building countries.¹ These proposals were supported at the all-Union meeting of workers of the machine tool industry in January 1931 in connection with the need to secure a full transition to new models in 1931-32. At the same time it was stressed that the design offices at the factories would have to be strengthened and production workers retrained to carry out design work.²

In June 1931, in accordance with an order of VSNKh of May 3rd, the new research institute, the Scientific Research Institute for Machine Tools and Tooling (hereafter, NIISTI - nauchno-issledovatel'skii institut stanki i instrument) began work. Its main function was to study and test foreign machine tools and assess their suitability for production in the Soviet Union in the light of the needs of industry. It was also to bring together the research forces of the branch, train cadres, disseminate technical literature, lead the work of factory laboratories, and elaborate standards.³ In November 1931 the machine tool industry's TSKB was created, with the function of elaborating the designs of new machines.⁴ Construction of the new experimental factory of new designs was delayed; work began in 1932 on a site near the im. Ordzhonikidze factory. Project capacity was fixed at 275 units a year and the total value of the project at 5-6 million rubles.⁵ In June this enterprise, 'Stankokonstruktsiya', was made a 'shock project' by NKTP.⁶ Its first machining-assembly shop was in operation by May 1934, when one hundred workers were employed, drawn from 'Krasnyi Proletarii' and the auto-tractor factories.⁷ However, although a working enterprise, 'Stankokonstruktsiya' had still not been completed by 1936.⁸

1. See American machinist, Vol. 72, 1930, pp. 462 & 757; Vol. 73, p. 575 for the state of research in Germany and the USA.

2. SI, 1934, No. 10, p. 6.

3. SI, 1931, No. 10, pp. 1-2; 25 let ENIMS, M., 1958, no pagination.

4. 25 let ENIMS, op cit.

5. Ek. Zhizn, 24.1.32.

6. SI, 1932, No. 7, p. 2.

7. 25 let ENIMS, op cit.

8. Narodnokhosyaistvennyi plan na 1936 god, M., 1936, Vol. 2, p. 328.

It is evident that in the years 1931 and 1932 the leadership of the branch regarded the TsKB as a more immediately important organisation than NIISTI, and the latter seems to have had a somewhat shadowy existence. In statements and articles on policy and the work of the industry Al'perovich stressed the vital role of the TsKB in preparing designs for assimilation in 1931-32, and in laying the design foundation for an expansion of the product range during the Second Five-year Plan.¹ At the First Conference of Designers in July 1932 Al'perovich stressed that the immediate task of the industry was not the design^{ing} of original machines, but the drawing up of designs based on the best foreign models. He was not against invention, he emphasised, but believed that it would develop later when a proper design and experimental base had been created. NIISTI, he added, was 'an extremely young creation', without its own cadres, and it would, he believed, be at least two years before it was up to its job.² Given the nature of the problems faced by the industry in 1932 and the scarcity of resources, notably skilled engineering and design cadres, this attitude is understandable. NIISTI's work was complicated by the lack of proper premises - it was located in seven different places! At one point, apparently in 1932, the leadership of the branch decided to close down the Institute on the grounds that money was lacking for its maintenance, but this decision was reversed after the intervention of the Party organisation.³ At the July 1933 All-Union Conference members of the Institute (Shaumyan and Mashnev) claimed that uncertainty about its future was an important factor in its unsatisfactory work: Shaumyan even suggested closing it down and trying again!⁴ The main positive function served by NIISTI appears to have been that it gathered together a nucleus of specialists which was to form the core of the future research organisation of the branch.

On 19th May 1933 Stankooob"edinenie called for the merging of the TsKB and NIISTI to form a new organisation, the Experimental-Scientific Research Institute of Metal-cutting Machine Tools (usually known as ENIMS - Eksperimental'nyi

1. Zand., 7.11.31; SiI, 1932, No. 1, p. 2.

2. SiI, 1933, No. 1, p. 2.

3. Stenogrammy - pervogo vsesoyuznogo soveshchaniya, op cit, p. 68.; Byli industrial'nye, M., 1973, p. 160.

4. Stenogrammy, op cit, pp. 62-64; 68-69.

nauchno-issledovatel'skii institut metallovezhushchikh stankov) with 'Stankokonstruktsiya' as its experimental production facilities.¹ This merger appears to have been realised after the First All-Union Conference in July. At the end of June the first director of ENIMS was appointed - E.E. Levin, a close colleague of Al'perovich in Orgametall in the 'twenties and prior to his appointment a deputy head of Stankoob"edinenie.² He was also made director of 'Stankokonstruktsiya'. At the time of its formation ENIMS had a staff of 250, including 125 designers and 50 members of the research sector. Of the designers, ten were foreign specialists; there were no foreign specialists in the research sector.³ The TSKB component of the institute worked on a khozraschet basis.⁴

The new institute grew rapidly. In 1935 it had a staff almost 400, including 65 research workers;⁵ by the autumn of 1936 it had a total staff of 526.⁶ In 1935 its annual budget amounted to 3.2 million rubles.⁷ The primary functions of ENIMS were as follows: serving the machine tool and tooling industry with theoretical and experimental research, providing assistance on a consultative basis, establishing the tipazh⁸, projecting machine tools, developing standardisation, and the building of prototypes and special machine tools.⁹ In 1933 Al'perovich observed that it had a further important function: 'attacking conservatism'.¹⁰ Within the Institute¹¹ there were three main sectors: research, technological and design; an office of standardisation and normalisation, and a number of laboratories, including chemical and metallurgical. The research sector was subdivided into a number of sections - for machine tools (further subdivided into groups by type of machine), tooling, machine tool automation, electrification, and hydraulics. The machine tool section studied technical developments, tested foreign and Soviet machines, studied machines in use in industry, participated in the establishment of the tipazh, and elaborated 'technical

1. 25 let ENIMS.

2. ZaInd., 26.6.33. Many of the leading staff appear to have been former Orgametall workers - Shaumyan, Zernov, Golovin, Besprozvannyi, Gorokhov, etc.

3. 25 let ENIMS; Stenogrammy, op cit, p.69.

4. Industrializatsiya SSSR, 1933-1937, p.250.

5. Armand, A.A. (ed.), Nauchno-issledovatel'skie instituty tyazheloi promyshlennosti, M.-L., 1935, p.597.

6. ZaInd., 29.9.36.

7. Armand, op cit, p.597.

8. The role of the tipazh is considered below, p.310.

9. ibid, p.591.

specifications' (tekhnicheskie zadanie) for new machine tools. The latter was regarded as the most important work of the section, which also participated in approving projects elaborated by enterprise design offices. The technological sector had as its main task the surveying of branches of industry in order to establish an optimal tipazh. When suitable models were not available it recommended the modification of an existing machine or proposed that an original design be created. The third, design, sector (the former TsKB), had the task of drawing up technical projects of new machines. As most project work on normal machines was undertaken by enterprises themselves, the design sector concentrated on projecting machines with new or unusual kinematics or principles of machining, machines with a high degree of unification of parts and assemblies, and special and unit-construction machines. The sector also studied and approved projects drawn up by enterprise design offices, planned design work for the industry as a whole and was responsible for overseeing and assisting the work of factory design offices.¹

At the beginning of July 1937 after repeated attacks on the work of the Institute in the press E.E.Levin was removed from the directorship of ENIMS and 'Stankokonstruktsiya', ostensibly for the failure of the latter to fulfil a major assignment for the production of special machines for the reconstruction of the tractor factories.² During the Third Five-year Plan period ENIMS was headed by I.F.Maslennikov, while two other young Soviet trained specialists took over the posts of chief designer of 'Stankokonstruktsiya' (V.I.Dikushin, the pioneer of unit-construction machine tool building in the branch), and chief engineer (S.M.Shifrin).³ Also during the Third Plan, by the SNK decree of 4th September 1939, ENIMS was removed from Glavstankoprom and subordinated directly to NKTyazhMash.⁴

While ENIMS was the leading R.&D. organisation of the machine tool industry during the 1930s it was by no means the sole establishment engaged in research and design of machine tools. Apart from the factory facilities, there were a

10. Plan. Khoz, 1933, No. 8-9, p. 49.

11. The following account applies to the situation in 1935 - there appears to have been a reorganisation later in the decade.

1. Armand, op cit, pp. 594-595.

number of other interested organisations. In 1932 a filial of the TsKB was created in Leningrad, specifically charged with the task of designing heavy machine tools.⁵ In 1936 this office was dissolved and became part of the department of heavy machine tool building which it was then proposed to organise on the site of the 'Tsentrolit' works. When this project was abandoned in 1937 the department was reorganised to form the independent Central Design Office of Heavy Machine Tool Building (TsBTS) in Leningrad. This design office projected many heavy machine tools for construction at various factories throughout the Soviet Union and also helped to organise heavy machine tool building at the im.Sverdlova works.⁶ Research into machine tools was also carried out by Orgametall. In 1933 a shop of experimental machine tool building was organised and, to the order of NKTP, it worked out the project for a centreless grinding machine and three such machines were built at the Orgametall factory. This shop also designed machine tool accessories.⁷ Some R.&D. was also carried out by NIIMash⁸, and design work was undertaken by the Ukrainian NIIMash in Kiev.⁹ Throughout the period some of the most original R.&D. work in machine tool building was undertaken by the Central Institute of Labour in Moscow under the leadership of A.K.Gastev and N.Bakhrakh.¹⁰ Finally, theoretical research was carried out by members of the Moscow 'Stankin', where machine tool industry specialists¹¹ were educated, and other higher technical institutes and universities, notably at the Moscow Higher Technical University, where a kafedr of metal-cutting machine tools was organised in 1930 under the leadership of G.M.Golovin.¹²

2.ZaInd.,4.7.37. The organisation of mass production of the 'STZ-NATI' crawler tractor was delayed because of the failure of the machine tool industry to deliver vital special machines on time - ZaInd,30.5.37;14.7.37;30.7.37.

3.Mashinostroenie,4.10.39;24.11.39;15.2.40.

4.Direktivy KPSS i sovetskogo pravitel'stva po khozyaistvennym voprosam,M.,1957, Vol.2,p.605.

5.Sil,1933,No.1,p.7.

6.Avtomatizatsiya i mekhanizatsiya proizvodstva,1967,No.11,p.5 ; Mashinostroenie, 17.6.40.

7.10 let Orgametall,op cit,pp.55-56.

8.See,e.g.ZaInd.,17.5.36 - the institute was building an original automatic machine tool, apparently of Shaumyan design.

9.ZaInd.,8.5.34.

10.See Appendix 7.

11.The development of Soviet theoretical research is reviewed by Acherkan in Izvestiya vysshikh uchebnikh zavedenii - mashinostroenie,1967,No.10,pp.120-128.

12.Ibid.,1968,No.9,p.128.

Enterprise R.&D. Facilities

Prior to the formation of the central research, design and development facilities described above, individual enterprises were responsible for their own development work in introducing new models. As the 1929 NK RKI survey revealed, there was no coordination of policy and factories often chose backward designs. The strengthening of the factory design offices (hereafter ZKBs) began seriously in 1930-31 as enterprises strived to renew their product ranges. By the end of the First Five-year Plan period such enterprises as 'Krasnyi Proletarii', im. Sverdlova, im. Lenina, Tula and Izhevsk had quite strong ZKBs, and design offices were quickly organised at the new enterprises, Gor'kii and im. Ordzhonikidze. At an early date the question of the relationship between the ZKBs and the TsKB naturally arose, and was a topic for discussion at the First Conference of Designers in the summer of 1932. In 1930, as noted above, Al'perovich had expressed the view that the preparation of working drawings for new designs should be left to the factories themselves, leaving the TsKB to draw up the general design specification. This view was reiterated at the Conference: the task of the TsKB, Al'perovich stressed, was not to replace the ZKBs but to strengthen them by working out standards, producing guiding materials, helping with the exchange of experience, and drawing up individual, original designs. This perspective was reaffirmed at the 1933 All-Union Conference: ENIMS was to draw up technical specifications, while the ZKBs would be strengthened so that they could as quickly as possible undertake independent work on the elaboration of working drawings on the basis of guiding materials produced by the Institute.² Some aspects of the interrelationship between ENIMS and the enterprise design offices are considered below.

Throughout the 1930s the ZKBs employed in total more designers than ENIMS. In early 1934 the total design force of the machine tool industry numbered 400 people³; by the beginning of 1935 it had reached 600, of whom 200 were employed in the design centre of ENIMS and 400 at the ZKBs.⁴ These totals

1. Nevertheless, the KB of the 'Krasnyi Proletarii' factory, probably the largest ZKB at the time, had only 19 workers in early 1933, of whom 5 or 6 were highly skilled - *Stenogrammy, op cit, p.103.*

2. Ibid. nn. 24 and 241.

apparently include designers at the 'planned' enterprises. For comparison, there were about three thousand designers in the German machine tool industry in 1935.⁵ By the end of the period most of the specialised factories had their own design offices, but by no means all of the 'planned' enterprises.

In order to facilitate the assimilation of new models it was decided, apparently in 1933, that leading enterprises should organise their own experimental shops for building prototypes. Such shops were organised in 1933 at a number of factories, including 'Krasnyi Proletarii' and Khar'kov.⁶ By 1935 the 'Krasnyi Proletarii' experimental shop had a staff of a hundred and had achieved some notable successes in building examples of complex new machines in a short period of time⁷. But throughout the period, despite frequent conference resolutions, orders and decrees, problems were experienced in keeping these shops free from current production work.⁸

The third component of the enterprise R.&D. system was the factory laboratory. Such laboratories were organised at a number of leading enterprises, one of the first and most important being that of the 'Krasnyi Proletarii' factory, created in 1930. A description of the laboratories of this enterprise in 1935 will serve to indicate the nature and scope of their work. The laboratories, for metal-cutting, metals and measuring, were directly subordinated to the factory technical director. The metals laboratory had chemical, heat treatment and metallurgical departments which served production by analysing materials and semi-fabricates in order to raise their quality, and also undertook more basic research into the structure and hardness of metals.⁹ With the development of the Stakhanovite movement stress on factory research increased and was a major concern of the Fourth Conference of Designers in April 1936, the resolutions of which outlined an ambitious research programme directed towards design improvement and the raising of quality.¹⁰ In general, however, the work of the factory laboratories was rarely mentioned in articles and speeches by leaders of the industry.

3. *Za Ind.*, 26.4.34.

4. *7 s"ezd sovetov*, op cit, *Byulleten'*, No. 10, p. 45.

5. *Plan. Khoz.*, 1935, No. 7, p. 30.

6. *SiI*, 1934, No. 1, p. 3.

7. *Izvestiya*, 5.7.35.

8. See below, p. 329.

9. Armand, A. A. (ed), *Zavodskie laboratorii tyazheloi promyshlennosti*, M.-L., 1935, pp. 98-100.

10. *SiI*, 1936, No. 6, pp. 3-5.

The 'Tipazh'

Before determining the specifications of new machines to be built by the Soviet machine tool industry it was necessary to establish the range of types and sizes of machine tools required by industry and other users. This aspect of technical planning, the compiling of the 'tipazh', was the responsibility of the technological sector of ENIMS, with the participation of the research sector and concerned branches of industry. Later in the period a specialised Office of the Tipazh was organised within ENIMS.¹ During the early 'thirties this work was lead by A.A.Zernov, a former Orgametall worker, and later by A.I.Ignatenko.² From about 1933 or 1934 there was also an Office for the Machine Tool Tipazh attached to the production-technical sector of NKTP. This appears to have provided a forum for the participation of major users, but nothing is known about its operation or relationship to GUSIP.³

Centralised planning of the product range effectively dates from 1932. The usual procedure prior to this was described by Lebyachenko, a Stankoob"edinenie official, as follows:

"Factories usually chose the machine tool most convenient to themselves, copied it, introduced additions or changes into the design, revised some assemblies using their own design forces and put it into production. Thus the selection of models was neither rigorous nor regulated and the demands of customers were little considered in view of the scarcity of machine tools".⁴

The 1932 annual plan included a target for the number of new types and sizes to be built by the specialised industry, and in the course of the year mounting attention was devoted to the question of expanding the tipazh⁵ and securing a rational choice of types and sizes; this concern stemming in part from problems encountered in assimilating new models and also the controversy provoked by the 'DIP' lathe. By the NKTP order of June 1932 Stankoob"edinenie was granted the right to exercise technical control over machine tool building carried out at factories of other organisations and the authority to name the types and sizes to be produced. Furthermore, the drawings of all new machines were to be approved by Stankoob"edinenie before they could enter production.⁶ This measure, which

1. ISI, 1943, No. 9-10, p. 7.

2. ibid., p. 2.

was to be reaffirmed in the NKTP order of the following June⁷, provided an essential precondition for central planning of the product range for the industry as a whole.

The idea of the tipazh was closely linked with that of tipizatsiya - the reduction of the available range of types and sizes to a rational and acceptable minimum. Given the vast range of types and sizes of machine tools on the world market the Soviet industry, faced with the demand for a rapid expansion of the product range, needed to draw up a minimum nomenclature of machines sufficient to satisfy the main requirements of industry, in particular its high priority branches. The tipazh itself was evidently not a fixed and binding plan but, as it was described in 1933, an 'orientational nomenclature', designed to reconcile the interests of both producers and consumers. The first tipazh was drawn up in the summer of 1933, incorporated in the 16th June NKTP order, and discussed at the subsequent All-Union Conference. The order outlined a programme of 200 types and sizes to be introduced by both specialised and 'planned' factories, in addition to the 40 already in production. It is clear that the demands of the defence industry took first priority; introducing the tipazh at the Conference, Levin revealed that during the first half of 1933 the ob"edinenie had been working with a series of large-scale machine users, including Glavaviaprom and the All-Union Gun and Arsenal Trust, in order to clarify needs.⁸ The order indicated that the tipazh would undergo further concretisation in cooperation with the glavki of the auto-tractor, aircraft and rail transport machine building industries. This first tipazh, amended and supplemented, provided a general framework for annual plans for the assimilation of new models and a basis for planning the specialisation of enterprises.

As a result of discussion with the relevant branches a tipazh for the auto-tractor industry was finalised in 1934. Whereas the ZIS factory alone had

3. It is mentioned in ZaInd., 2.4.34.

4. Lebyachenko, op cit, p. 45.

5. This term began to be employed regularly in 1932, e.g. SI, 1932, No. 2, p. (Al'perovich)

6. SI, 1932, No. 7, p. 2.

7. Ibid., 1933, No. 6, p. 2.

8. Stenogrammy, op cit, p. 90.

about 500 different types and sizes of machine tools in its stock, the tipazh for the branch as a whole was reduced to 240 types and sizes.¹ Similar work was carried out for the aircraft industry, leading to a tipazh of 250 types and sizes, moreover, the types were unified with those required by the motor industry.² At the Third Conference of Designers in March 1935 the tipazh of high-productivity machines for the auto-tractor and aircraft industries, together with that for the rail-transport equipment branch, were discussed and the allocation of new models between factories of the industry clarified.³ It was probably inevitable that with the centralisation of decisions relating to the product range and the choice of specific designs for production in the hands of a relatively inexperienced and understaffed organisation working under considerable pressure disagreements would arise over the way in which the work was being carried out and the final decisions reached. From about 1934 such controversies became a regular feature of the development of the industry. The most frequently voiced criticism was that users had not been properly consulted in drawing up the tipazh.⁴

Criticism of ENIMS and the Glavk reached its highest level when a draft tipazh for the Third Five-year Plan was unveiled in the spring of 1937. Whereas the tipazh for the Second Five-year Plan was elaborated after the start of the Plan period, work on the tipazh for the next five years began before the start of the new period at a time when directives for the Plan had not been issued by Gosplan⁵. The draft tipazh was discussed at a meeting of GUSIP in May 1937, when Al'perovich revealed that about 1,000 types and sizes would be required in 1942 (including specials) compared with the 350 which would be in production at the end of 1937.⁶ This tipazh, prepared by ENIMS, appeared at a time when the Glavk leadership was under mounting attack and immediately became the object of fierce dispute. the main criticism was that user branches had been inadequately consulted, with the result that it had been compiled by statistical

1. Izvestiya, 27.5.34.

2. Plan. Khoz., 1935, No. 3, p. 36.

3. ZaInd., 22.3.35; SiI, 1935, No. 4, p. 1.

4. For example, Shifrin, ZaInd., 2.4.34.

5. SiI, 1938, No. 2, p. 5. Directives for the Five-year Plan for GUSIP had not been received by February 1938.

6. ZaInd., 8.5.37.

methods rather than by analysis of concrete requirements.¹ Under new leadership the Glavk and ENIMS continued work on refining the tipazh for 1938-42 and eventually a final target of 1,021 types and sizes was agreed, of which 814 would be basic model as opposed to specials built on a one-off basis.² The actual Five-year Plan incorporated a target of 800 types and sizes to be built in 1942.³ With the break up of NKTP central control over the tipazh appears to have weakened, but in September 1939 the SNK decree gave NKTyazhMash responsibility for leading the work of establishing the tipazh for all Commissariats, although special machine tools were excluded from this ruling.⁴

The tipazh, despite its weaknesses, represented a bold attempt, unique in world practice, to rationally plan the product range of the machine tool industry. It was an important lever of centrally determined technical policy and provided a framework for establishing annual plans for new types and sizes, for planning factory specialisation, and for drawing up the technical specifications for specific models. This latter question will now be considered.

The Procedure for Introducing New Models

From an early date the Soviet machine tool industry established a standard procedure for introducing new models which was to remain basically unchanged throughout the period in question. This procedure was designed to meet the circumstances of an acute scarcity of design and technical skills and the need to secure a unified technical policy. The basic elements of the process were laid down in 1932-33. The vital first stage in preparing the introduction of a new model was the compilation of a 'technical specification' (tekhnicheskie zadanie) by the research organisation (NIISTI, later ENIMS). The necessity of adopting this approach was outlined at the First Conference of Designers in 1932 by V. Morlok in a report on documentation procedures for innovation. Instructions for the procedure had been drawn up by the TsKB on the basis of materials supplied by the German Committee for the Economics of Production⁵. The technical specification was drawn up on the basis of comparative study of

1. ZaInd., 10.5.37; also 12.5.37; 29.6.37.

2. Ocherki razvitiya tekhniki v SSSR - mashinostroenie., M., 1970, p. 78.

3. XVIII s"ezd VKP(b), Sten. otchet., M., 1939, p. 653.

available foreign and Soviet machines and assessment of the requirements of Soviet industry. It laid down the basic dimensions, technical characteristics, and the data needed by the designer in making a full project of the machine.⁶ The resolutions of the 1933 All-Union Conference laid down a procedure for technical specifications applicable to both the specialised and 'planned' enterprises: "Considering it impermissible in the future to continue the practice of producing machine tools of haphazardly chosen models according neither with the needs of the country, nor with present-day technical demands, it is acknowledged as necessary to establish henceforth an obligatory procedure according to which the design elaboration of no machine tool ... can be started without preliminary examination of the technical specification by ENIMS and its approval by Stankoob"edinenie".⁷ Only one case during the Second Five-year Plan of a factory infringing this rule and building a machine without the prior approval of its technical specification by ENIMS has been traced - the im.Maslennikova (military) factory in 1935; ENIMS called for a complete redesign of the machine.⁸

The procedure for approving new types of machine tools during the 1930s was not as strict as that for certain other types of machinery. In September 1934 SNK USSR issued a decree ('On the procedure for approval of new types of machines and equipment') which made STO responsible for the approval of the basic technical characteristics of a wide range of machines intended for mass production, including motor vehicles, turbines, locomotives, aircraft, textile and printing machinery. Machine tools were excluded, indicating that approval ultimately rested with NKTP.⁹ The splitting up of NKTP from 1936 and the further fragmentation of Commissariats which took place in the years 1937-39 must have greatly complicated control over the types of machines built, and measures taken in the

4. Direktivy KPSS..., op cit, Vol 2, p.605.

5. 311, 1933, No.1, p.13.

6. 25 let ENIMS.

7. Stenogrammy, op cit, p.239.

8. ENIMS, Sbornik materialov po stankostroeniyu, M, 1935, p.32.

9. SZ, 46-364-1934.

autumn of 1939 were clearly intended to tackle this problem. The September 1939 SNK decree referred to the low quality and obsolete designs of some machines built outside NKTyazhMash and laid down that the types and sizes of new machines to be built at all factories were to be approved by Ekonomsovet of SNK USSR, and that no new machines could be built without the prior approval of NKTyazhMash.¹

Given the approval of the technical specification, the next stage of the innovation process was the elaboration of the technical project, which was the main work of the designer, either at the ZKB or, if the machine was of an unusual or special type, at ENIMS itself. While many of the models built during the 1930s were based on foreign designs, it is evident that the designer's work was not restricted to copying. As leaders of the industry stressed on many occasions, foreign machines had to be 'translated into the Soviet language', i.e. many machines had to be converted into metric dimensions, Soviet standards and standard parts had to be included and some elements of the machines changed to facilitate production or adapt the design to new conditions of work, different materials, etc. . According to an American designer, who worked at ENIMS in the early 'thirties, all contracts for the design of new machines included a clause calling for the maximum use of standard items, and standardisation policy followed German practice in its thoroughness.² All projects were checked by the design sector of ENIMS before approval, partly to ensure that standards had in fact been observed, after which working drawings could be prepared as a basis for building the first prototype.

Prototypes of many new models were built by the enterprises which were to produce them on a batch basis.³ For the new enterprises of the First Five-year Plan prototypes were built at existing factories with the participation of specialists from the new works so that design and production technology were clarified and checked before the new factories went into operation.⁴ Later in

1. Direktivy KPSS, op cit, Vol.2, pp601-605.

2. The machinist, 1933, Sept.27, pp.614-615 ; 1934, Feb.14, p.148 (Wasbauer).

3. This seems to have been particularly true of the leading specialised enterprises: almost all the models built by 'Krasnyi Proletarii', im.Ordzhonikidze, im.Sverdlova, and Gor'kii in the period were designed and developed by the factories themselves.

4. Thus, the 'Krasnyi Proletarii' factory built a prototype turret lathe in 1931 for the im.Ordzhonikidze works (Slavnye traditsii, op cit, p.25) and 'Samotochka' built a prototype milling machine for the Gor'kii factory (ZaInd., 20.5.31).

the 'thirties models which had been built on a batch basis at the main specialised factories were transferred to the enterprises of the 'planned' system, presumably with appropriate documentation permitting more rapid assimilation. The other main procedure was for workings drawings to be prepared within ENIMS and then used by factories in assimilating new models; this was the case, for example, with some of the gear-cutting machines built by the 'Komsomolets' factory and the series of unified lathes built by the Izhevsk works. But the practice of building prototypes of such machines at 'Stankokonstruktsiya' does not appear to have been adopted very often¹, factories apparently preferring to undertake their own development work on models which they were to build on a regular basis. It is evident that 'Stankokonstruktsiya' did not in fact perform quite the role originally foreseen. It did, however, play a very important role in building special machines and types not previously built in the USSR. Thus, it built many unit-construction machine tools supplied to the motor, tractor and aviation factories, vertical and external broaching machines, special milling machines for machining the tubing of the Metro and, during the Third Five-year Plan, a wide range of specialised, high-productivity equipment of vital importance to the defence industry.² Between 1933 and 1943 'Stankokonstruktsiya' built a total of 1,000 machine tools, 900 of which were of the unit-construction type.³

Before about 1939 it appears to have been the practice to carry out the stages of the innovation process consecutively, i.e. each stage would be completed before proceeding to the next. This was very time-consuming and was a major factor in the delayed introduction of many models. In 1939 a campaign developed in the machine tool industry (and other branches) for the rapid assimilation of new products. The essence of this new approach was that where possible, the stages of the process were telescoped by performing them in parallel. This method, a primitive equivalent of modern critical path techniques, was pioneered by

1. An exception was the '152' vertical turning and boring machine later built at the im. Sedina works in Krasnodar - serious problems of assimilation were nevertheless encountered - 50let Krasnodarskii stankostroitel'nyi, Krasnodar, 1961, pp. 480-49; Za Ind., 17.5.36.

2. 25 let ENIMS; Mashinostroitel', 1939, No. 1, p. 4.

3. Omarovskii, op cit, p. 61.

Dikushin, chief engineer of ENIMS and quickly taken up by the factories, notably im. Lenina and 'Krasnyi Proletarii'. Some very significant successes were claimed in reducing lead times and the movement was associated with a notable development in the use of standard parts and assemblies.¹

Financing and Stimulating Innovation

Little evidence is available on the procedures for financing innovation in the machine tool industry during the period, but an insight into the normal practice can be gained from critical comments at various times by machine users. Thus in 1936 two engineers of the ZIS factory complained that customers were being obliged to pay very high prices for machines in order to cover the costs of R.&D. and other overheads associated with their assimilation or modification.² At about the same time there were complaints by customers that when only insignificant changes were introduced in machines their prices rose sharply.³ It appears, therefore, that innovation costs were recouped largely through the high initial prices of new machines.

The Glavk did have some provision for covering innovation costs. In the financial plans of enterprises there was provision for special allocations for expenditure on assimilation of new machines; these covered costs involved in design work, producing technological projects, making prototypes and also tools and fixtures. Means for these outlays accounted for a significant share of total Glavk financial allocations to the enterprises, e.g. according to the 1936 GUSIP financial plan expenditure on the assimilation of new machines was to be 28,0 million rubles, or 42 per cent of total financial allocations. But this allocation for innovation entered the general account of the enterprise, i.e. it was not an earmarked grant. Enterprises frequently found themselves short of working capital because of the failure of customers to pay on time, with the inevitable result that the allocation for innovation was not spent as intended. In describing this practice, the head of the financial sector of the Glavk, Stepanov, called for the formation of a special earmarked grant for the finance of the assimilation of new products.⁴ There is no evidence that this proposal

was accepted at the time, but the September 1939 decree of SNK laid down that from the beginning of 1940 the financing of design and assimilation of new machines would be achieved through earmarked funds at each enterprise.⁵

The difficulties encountered in assimilating new models during the First Five-year Plan led to some consideration of providing material incentives for the introduction of new models. There does appear to have been an ad hoc system of rewarding good innovation performance from an early date: by an order of NKTP in April 1932 Stankoob"edinenie was granted 25,000 rubles to pay bonuses to designers, technical personnel and workers of the im.Sverdlova factory for the creation and production of the first Soviet heavy machine tools.⁶ At the 1932 conference of designers Al'perovich stressed the need to enhance the status of designers by creating a degree of material self-interest⁷; and the July 1935 NKTP order on the position of designers provided for the payment of bonuses for rapid completion of work.⁸ The resolutions of the Fourth Conference of Designers in April 1936 also outlined a series of measures for raising the status of designers, including an elaborate system of bonuses intended to stimulate the design of new products of a high technical level. For the design of an original, high-productivity machine at the level of American technology a bonus of 35,000 rubles was proposed.⁹ From later comments it seems unlikely that incentive schemes for designers were generally adopted at this time, but a successful bonus system for the assimilation of new models at the 'Samotochka' factory was singled out for praise.¹⁰

In September 1936 Stepanov, the financial head of GUSIP, put forward a radical scheme for stimulating innovation. Material incentives were necessary he believed because it was easier to produce established models and financial problems often arose when changing to new designs. It would be wrong to provide incentives simply by raising the prices of new machines, he believed, because this hindered their introduction at customer enterprises. Instead, Stepanov

1. Mashinostroenie, 24.11.39; Mashinostroitel', 1940, No. 3, pp. 1-11.

2. ZaInd., 22.10.36.

3. Ibid., 28.9.36.

4. Ibid., 28.7.36.

5. Direktivy KPSS, op cit, Vol. 2, p. 604.

6. Borisov and Vasil'ev, op cit, p. 138.

7. SI, 1933, No. 1, p. 1.

proposed that some of the savings obtained by user factories from reduced costs as a result of the use of the new machine should be returned to the maker factory to provide an incentive fund. The rate of refund would be determined by agreement between the two parties. This arrangement would apply only for the first examples of the new machine; with the assimilation of batch production normal prices would apply. This interesting proposal, foreshadowing ideas put forward in the 1960s, was not taken up.¹

During the Third Five-year Plan quite wide use appears to have been made of incentive schemes for design and development work, and such schemes were a regular component of rapid assimilation methods.² The September 1939 decree provided for a broader system of incentives for designers and production engineers for good performance in producing new machines³, and the December 1940 SNK and Central Committee decree also laid down conditions of payment of bonuses to personnel involved in successful innovation work. This decree permitted the naming of new machines after their designers, and provided for the establishment of a scale of bonuses of from 10,000 to 50,000 rubles for the creation of high-productivity machines.⁴

It is clear that the principle of providing material incentives for designers and other specialists engaged in the creation and assimilation of new machine tools was accepted by the Party, government and leaders of the industry from an early date. It is not clear, however, that incentive schemes were generally adopted at the machine tool factories: the fact that provision for bonuses had to be reaffirmed in successive decrees and resolutions suggests that they were not adopted by all enterprises, but the reasons for this are never indicated.

8. ZaInd., 18.5.35.

9. SiI, 1936, No. 6, pp. 3-4.

10. Plan. Khoz., 1938, No. 9, p. 47.

1. ZaInd., 28.7.36.

2. For example, at im. Lenina, Mashinostroitel', 1940, No. 3, pp. 8-9.

3. Direktivы KPSS, op cit., pp. 604-605.

4. Omarovskii, op cit., p. 86.

Some Problems of Innovation

Having considered a number of features of the research and development system, we now turn to some of the problems of assimilating new models in the period 1932-1941, including the question of the relationship between the central R.&D. organisation and the enterprises, and the functioning of ENIMS itself.

During the second phase of the branch's development, when the introduction of a limited number of new, modern models replacing designs dating from long before was the main priority, the ob"ednenie did not possess a serious R.&D. infrastructure. The problems of assimilating the complex new models and mastering the new production technology fell on the factories themselves and, not surprisingly some serious difficulties were encountered. In 1931 a number of factories were quite successful in building prototypes of new models and this may have helped to create a mood of excessive optimism about the possibility of very rapidly assimilating new products; an optimism expressed in the plan for 1932, which called for the full replacement of old models during the year such that new products would account for 43 per cent of total output in value terms.¹ But even at the beginning of 1932 Al'perovich was warning that: "As a rule, under pressure of a fixed programme of quantitative output of old models, factories lag very greatly in design work and to a still greater degree in the technological preparation of machine tools of new design".² Problems of assimilating batch production of new models were high on the agenda of the session of the NKTP collegium on 5th April 1932 at which problems of the industry were discussed. Al'perovich here stressed the need to strengthen design forces, and Ordzhonikidze made it absolutely clear that the first priority of the branch was to be the replacement of old models even at the cost of a possible temporary fall in output.³

1. SiI, 1932, No. 1, p. 1; No. 2, p. 2.

2. SiI, 1932, No. 1, p. 1.

3. ZaInd., 6.4.32. Recalling this occasion later, Al'perovich quoted Ordzhonikidze as having said that: "A modern army will never be battleworthy if it only has a large quantity of munitions. The battleworthiness of a modern army is determined not only by the quantity of munitions, but in the first instance by their technical level. What do you want to do - arm our growing and developing country with backward technology, albeit in a large number of units? That is not what we need. Whatever happens you must force all the factories to overcome this

The problems of assimilating new machines at this time were legion: skilled workers and specialists were lacking, the production technology was new, quality standards were much higher than before, the problems of preparing jigs and fixtures were much greater than envisaged. In some cases designs had to be modified in order to facilitate their batch production, e.g. the 'Warner and Swasey' turret lathe introduced at the im. Ordzhonikidze factory.¹ Output did fall, and would have fallen much further if factories had not maintained a high level of output of old models. Nevertheless, in 1933 regular batch production of a number of complex new models was established and much valuable experience gained. One of the lessons, as Al'perovich indicated at the First Conference of Designers was that the designer was the crucial figure in the machine tool industry; his status had to be improved and managers and production engineers educated to appreciate his importance. As noted above, at this conference Al'perovich attempted to build up the professional pride of the then very weak design cadres as a progressive force countering the conservatism of the production men.²

The transition to the third phase of development of the industry with primary emphasis on rapidly expanding the product range had the implication that innovation was now a permanent and central concern of the industry, perhaps to a greater extent than in any other branch of civilian engineering. ENIMS had just been created and was expected to immediately lead a massive design and development programme. In the first half of 1934 the Glavk appears to have pursued a policy of highly centralising design work, and as a consequence became the target of much criticism as plans for the assimilation of new types were not fulfilled.³ In response to criticism the director of ENIMS, E.E. Levin, argued that the main problem was the lack of designers in ENIMS and at the factories. There was little incentive for the best production workers to become designers,

inertia and conservatism and, regardless of the sacrifice, embark on the creation of new, modern machines. Don't worry if for some time this or that factory doesn't make any machine tools at all. Very well, for a time certain factories will not turn out machine tools at all, but it is essential to put the factories in such conditions that they cannot but embark on a new path". (SiI, 1937, No. 8, p. 1)

1. ZaInd., 29.10.32.

2. SiI, 1933, No. 1, p. 1.

3. See, for example, ZaInd., 22.3.34; 29.3.34; 2.4.34.

he added, because wages lagged behind those of engineers and shop production men, and the general status of the profession was low. Levin conceded that ENIMS was not yet fully up to its job, adding the unfortunate comment (later to be used against him) that : " It would have been necessary to have sharply expanded the design force two or three years ago and in advance gone to the expence of training the necessary cadres, for the machine tool industry to be able now to cope with the tasks which have been entrusted to it".¹ This simply indicated, a critic responded, that Levin doubted the reality of the industry's plans.²

This skirmish over the problems of introducing new models foreshadowed a much more serious conflict which broke out in late May 1934; a controversy which raised many central policy issues in an acute form. The opening shot was fired by Berzin, deputy chief engineer of the Khar'kov factory, who attacked the policy of the Glavk and ENIMS in selecting types of new machines for Soviet production. There was a widely held belief, he claimed, that the choice of types had already been determined by foreign machine tool builders and that a programme could be drawn up simply by looking at foreign catalogues. A model chosen for production at Khar'kov exemplified this approach, Berzin claimed: the '256' radial-drilling machine was highly universal, had a complex gear train making production difficult, and had an elaborate system of controls. Furthermore, it was quite unsuitable as a basis for a range of types and sizes. It emerged that this model was a 1929-30 'Cincinnati-Bickford' machine, which in America had since undergone modernisation, although the nature of this modernisation was unknown to ENIMS. Berzin called for action by Al'perovich, including the transference of all practical project work on new machines directly to the ZKBs, leaving ENIMS with the job of approving technical specifications and technical projects.³

In response to this criticism Levin stated that the '256' had been projected at the beginning of the First Five-year Plan (i.e. over four years earlier) by Soviet designers with foreign technical assistance. It would be difficult to

1. ZaInd., 29.3.34.

2. ibid.

3. ZaInd., 24.5.34.

change the model , he added, because it took about a year to design a machine of this type. As for creating an original Soviet type of radial-drill (which was clearly what Berzin had in mind) Levin rejected this possibility on the grounds that it was better to master the production of an existing type first, i.e., "to achieve the level of foreign technology, and then set about improving it".¹ "But , in so far as world technology does not stand still ", a Za Industrial-izatsiyu writer sarcastically , but not unfairly ,observed , "comrade Levin risks repeating old models all the time". One of the designers involved in the '256' project also noted that technology was moving forward, "despite the crisis in the West", but favoured the building of the model precisely because of its complexity. The experience of the 'DIP' had shown , he claimed, that after assimilating one of the most complex types a factory had no trouble with the rest.² This position, 'the most complex first' was supported by an engineer of the im.Ordzhonikidze factory having long experience working in Germany.³

A month after Berzin's contribution another Khar'kov worker , Penkov, entered the dispute; this time focusing on ENIMS's choice of grinding machines for production at the factory. The model, '3A-12' cylindrical grinding machine, was considered dated by the factory, which had had to struggle with ENIMS for the right to improve it. In Penkov's opinion it was necessary to take greater technical risks if foreign technology was to be caught up .⁴

The Khar'kov case raised a number of central policy issues: first, the desirable degree of universality of Soviet machine tools; second, the question of whether foreign designs should be copied or original models created; third, the problem of 'catching up and surpassing' in circumstances where the target was moving forward; and, finally, the question of the relationship between ENIMS and factory design and development forces. The first question is considered elsewhere.⁵ The problem of copying versus original design was a relatively new one for the branch, but one which was to become more prominent from this time on

1. ibid.

2. ibid.

3. ZaInd., 22.6.34.

4. ibid.

5. See Chapter 7.

as new, young designers and engineers strived to break away from the practices of capitalist machine tool building. There was a real dilemma here for ENIMS and the Glavk - should such initiative be encouraged at the risk of jeopardising the output plans of the industry, and maintaining import dependence, in the event of failure of the project. In the case of the new Khar'kov works, which had only just started regular production, ENIMS caution is understandable. The strength of the designers and engineers arguing for change at Khar'kov must in part have stemmed from the fact that the experimental shop of this enterprise had been created some time before production had been assimilated, so that the vested interests of current production were as yet weakly developed. The subsequent experience of the factory, which won the battle to design its own new models, suggests that ENIMS should perhaps have been firmer in insisting that the 'old' models be successfully produced on a batch basis before the path of original design was taken.¹

On the third point, this was probably the first case in which the problem of technical progress during the crisis arose in a practical way. The dilemma was summed up by a journalist, Peshkin, in a comment on the case: "ENIMS proposes that we achieve the level of foreign technology and then start improving it. As a result we find ourselves in the situation of Achilles and the tortoise; if not even worse, because we shall lag at the time of research, design and production".² There was no easy answer for ENIMS. Design work would have to be greatly speeded up, the most recent models copied and procedures adopted enabling modernisation to take place as a regular phenomenon. All these were difficult to achieve at a time when design forces were few and inexperienced and pressure for current output was so strong. On the final point, the instructive feature of the case is that the enterprise, although inexperienced, was able to get its way. Possibly as a consequence of the Khar'kov dispute, there was a change of policy later in the year and the trend towards maximum centralisation of design work reversed, a greater role being given to the ZKBs.³

1. New, original models were successfully designed (the '2A56' radial drill - a very good machine by contemporary and later assessments, and the '316' grinding machine with hydraulic drive). ENIMS after raising objections finally approved the '2A56' design at the end of 1934 and the prototype was built in the summer of 1935; the prototype '316' was built in January 1935. A few examples of the
cont.next page...

In 1935 pressure on the industry for innovation further intensified. The Third Conference of Designers in March discussed a large programme of assimilation of specialised, high-productivity machines, while the sudden awakening of industry leaders to the extent of technical progress in the capitalist countries during the crisis lead to precipitate action to replace basic models introduced only three years earlier, notably the 'DIP' lathe and the '136' turret lathe. This decision had serious negative consequences for the 'Krasnyi Proletarii' factory. Work began on the assimilation of a new model based on American 'Monarch' design. This was a highly electrified machine with a maximum speed of 750 r.p.m. compared with the 'DIP's 600.¹ Large serial production was planned with a programme of 5,000 units a year, involving very great use of fixtures and special tooling, a large quantity of which was produced. Output was to begin in October 1936, reaching 400 units a month by November 1937 - a highly optimistic plan!² The machine was put into production in 1937, but the scale of production was very substantially less than envisaged and, in fact, the 'DIP', unchanged, remained the factory's basic model: plans for its withdrawal were delayed from year to year. From early 1937 the new 'type 26' (also known as the '162K') came under fierce criticism for alleged design weaknesses,³ and the decision to build this particular model began to be characterised as a 'wrecking' action. Thus, Shekvits claimed that 'wreckers' had delayed the production of the Type 26 for three years and had finally turned out a lathe of obsolete design in some respects inferior to the 'DIP'. "Several million rubles" had been "thrown to the wind", he added.⁴ The Type 26 was built during the Third Five-year Plan, but in relatively small numbers, and work began on a new replacement for the DIP, the Type 28, of much higher speed, allowing full use of hard alloy tools. This model was to form the

'316' were built in 1936, but the model was not a success - its hydraulic units were too elaborate for most normal purposes, and it appears to have been withdrawn before 1941, work on an improved model beginning in 1939. In the spring of 1937 Al'perovich noted dryly that the '2A56', admittedly a good design, was still not in production; output eventually began later in the year. As a result the Khar'kov factory's programme between 1934 and 1938 was fulfilled predominantly by building the despised older models! (*Khar'kovskii stankostroitel'nyi*, pp.16-17; 29-36; *ZaInd.*, 10.1.35; 5.11.36; 8.9.36; *Mashinostroitel'*, 1939, No.1, p.4; 1940, No.3, p.14; *StI*, 1937, No.8, p.2)

2. *ZaInd.*, 14.7.34.

3. *Predpriyatie*, 1934, No.19, p.7.

1. *ZaInd.*, 20.5.36.

2. *StI*, 1936, No.8, p.44.

basis for a series of variants, including a high-speed machine of up to 3,000 r.p.m. In May 1940 prototypes were accepted by a state commission but the war prevented its assimilation.⁵

This experience of the 'Krasnyi Proletarii' factory reveals clearly that the decision in 1935 to replace the 'DIP' was an expensive mistake. It would have been much more expedient for the Soviet industry to have followed the practice of the German makers of the 'VDF' lathe (on which the 'DIP' was based) and modernised the design in 1935-36, thereby providing Soviet industry with a modern machine suitable for use with hard alloy tools, which could have been produced on a large-serial basis for a number of years before requiring replacement. A substantially modernised 'VDF' was produced from 1934, providing greater rigidity and higher speeds: the basic version had a maximum speed of 1,050 r.p.m. and a special fine-turning variant 2,350 r.p.m., compared with the 600 r.p.m. of the original model.⁶ The case of the '136' turret lathe of the im.Ordzhonikidze factory is not so well documented, but this model had certainly not been replaced or modernised by 1938.⁷ In 1937 the realisation of this model replacement policy was sharply attacked and the GUSIP leadership blamed (although direct responsibility probably lay with NKTP and Kaganovich in particular).⁸

Despite the stress on design modernisation as a primary path of technical progress at the Fourth Conference of Designers in 1936, successes at the time were meagre. There was clearly powerful resistance to changing production technology to accommodate such design modifications: "We hardly engage at all in current changes in existing designs", one commentator observed in 1936, "Attempts by designers to introduce even the smallest changes in design frequently meet strong resistance from production men and senior management. This phenomenon, shameful for any machine tool factory worthy of the name, becomes completely intolerable in the Stakhanovite year, 1936".⁹ This problem was closely related to the main difficulty of innovation at this time - securing the transition from prototype to regular batch production,

3. For example, *ZaInd.*, 30.5.37.

4. *Plan. Khoz.*, 1937, No. 7, p. 42.

5. *SiI*, 1940, No. 10, pp. 18-25.

From as early as 1932 it had been recognised that building prototypes was one thing, and assimilating batch production of new models another. In the years 1933 and 1934 a number of factories achieved notable successes in building prototypes of new machines in a short time, e.g. 'Krasnyi Proletarii' built examples of the 'Sandstrand' multi-tool lathe in 6-7 months from the start of design work.¹ Once the prototype had been built the new model then entered the list of 'new types and sizes mastered in the year', and therefore counted towards the fulfilment of the annual new models programme. At this time it was certainly the case, as a Za Industrializatsiyu commentator observed, that, "By the concept 'assimilation' (osvoenie) the Glavk understands the production of the first prototypes"², and Shaumyan and Agapov were right when they declared in 1935 that targets for new types and sizes were even being overfulfilled, but partly because many prototypes were being included.³ In one of his last major speeches Al'perovich himself self-critically condemned the practice of 'formal assimilation' of new models: "For a number of years many of us have formally fulfilled the slogan of the Party with respect to the assimilation of new machines. New models were produced, but the country did not receive new machines ... This means that assimilation of a new machine is not just a matter of making a prototype, but the technological assimilation of serial production".⁴

6. Machinery, 1.3.34, p.650. VDF advertised this new version in the pages of Stanki i Instrument from 1934. This VDF modernisation was later praised by a Soviet specialist, Shekvits, in 1937 - Plan. Khoz., 1937, No.7, p.43.

7. Plan. Khoz., 1938, No.9, p.47.

8. See, for example, SiI, 1937, No.19, p.1.

9. SiI, 1936, No.1, p.1.

1. ibid., 1934, No.1, p.3.

2. ZaInd., 5.7.35.

3. SiI, 1937, No.8, p.2.

4. At the time of the fiercest attacks on the Glavk's leadership some vivid, if partial, descriptions of the practice of 'assimilating new models' appeared in the press, e.g. referring to the 'Krasnyi Proletarii' factory: "Comrade Zhabakov (the director) rushed to report the 'victory' of a rapidly 'assimilated' machine tool to the NK and the Glavk without awaiting the conclusions of the corresponding acceptance commission. Moreover, the reports of the director were accompanied by rousing speeches and endless noisy parades at the factory. The 'assimilated' machine tool was entered into the records of programme fulfilment, an invoice was filled in and it was sent to the finished products store. Several days later, when the 'thunder of victory' had subsided, the machine was quietly slipped back to the shop for 'corrections'" (ZaInd., 30.3.37).

The basic cause of the problem was also recognised: pressure for current production took first priority. Thus, as a Stanki i Instrument editorial noted in 1936, directors and managers strived for maximum output in value terms: ".... they do not hinder the fulfilment of plans for design work, because of course the making of drawings in itself does not impede plan fulfilment. They do not raise objections against making prototypes in the experimental shop either, provided there are machine tools and workers in it free from working on fulfilling the current programme for, as is well known, experimental shops at the majority of factories serve as a reserve for easing bottle necks in plan fulfilment".¹ The problem was one of overcoming the resistance to new models put up by those concerned with current production. It was also acknowledged by Berri that the sellers' market created unfavourable circumstances for innovation and that the Soviet economy lacked the forces promoting technical progress which existed in the capitalist economy: "Our machine tool builders have not yet become real pushers (tolkachi) of new technology", he wrote in 1938, "We do not have the fierce competition and the narrowness of the market forcing machine tool factories of capitalist countries to create new types of machines. Our machine tool building is secured a firm and wide 'sales market', but this does not mean that it may give our industry machine tools of obsolete design".² As noted in the first part of the chapter, machine tool builders in the capitalist countries tended to cut down their innovative activity when current demand was at a high level; in the Soviet case high current demand was a permanent state of affairs and a fact which the machine tool industry itself had to accept as given; all it could do was attempt to create conditions reinforcing the position of those representing the interests of change, in order that they might exert greater pressure on the stronger conservative force of those concerned primarily with current production.

1. SiI, 1936, No. 6, p. 1.

2. Plan. Khoz., 1938, No. 9, p. 47.

Strengthening the position of those concerned with change meant, in the first instance, enhancing the prestige of the designer and other workers directly concerned with innovation. This problem was discussed at the conferences of designers of the period, notably the third and fourth in 1935 and 1936. It was agreed that it was essential to overcome the tendency for designers to remain aloof from practical problems of building their own designs, and that they should follow their models from the drawing board to the time when they were withdrawn from production, working closely with production engineers.¹ The question of incentives for design staff has already been mentioned. The September 1939 decree revealed that many of the problems discussed during the Second Five-year Plan remained: designers were poorly acquainted with the technology of machine building, incentives were inadequate, and experimental shops were divorced from the design offices and used for current production. Enhancing the role of the designer was one direction of action. Throughout the period another source of pressure for change was the strong moral influence brought to bear on enterprise directors and managers by the Party, industrial leaders (notably Ordzhonikidze)² and the press, the latter playing a particularly active role. Mass campaigns also promoted technical change, notably the Stakhanovite movement, but also campaigns for higher quality, rationalisation and inventions, etc., and an active role was played by a number of voluntary organisations such as VARNITSO³ and VNITOMASH.⁴ These diverse pressures helped to create a climate in which neglect of change and technical progress became unacceptable, thereby providing a counterweight to the relentless pressure for output.

The intense pressure on the branch for the introduction of new models, coupled with the problems of assimilation at the enterprise level, led to considerable frustration and discontent which tended to be focused on ENIMS as the central R.&D. body of the branch. The 1934 problems with the Khar'kov factory were the first round in what was to be a prolonged battle between the Institute

1. *Za Ind.*, 27.3.35; 6.4.36; *SI*, 1936, No. 6, p. 1.

2. *Pravda* bluntly reminded the industry in February 1937 that, "The struggle for new technology, for technical progress, is not a neutral field far from the front of class struggle, from the front of the struggle against fascism". (14.2.37).

3. All-Union association of scientific and technical workers for assisting the socialist construction of the USSR.

4. The All-Union scientific, engineering and technical society of machine builders. See, e.g. *Vestnik metallopromyshlennosti*, 1935, No. 10, pp. 9-21 for its activities.

leadership and a range of critics, including disaffected members of its own staff, and representatives of both the machine tool building factories and machine tool using branches. Many issues were raised, but one of the main allegations was that the Institute was divorced from practice. Shumyan, one of the most persistent critics (he later claimed that he had five times created an office of automatics in ENIMS - which the leadership had five times closed down!)¹ declared in 1935 that, "Up to now ENIMS has represented only an establishment, an office, and not the living brain of machine tool building".² Some designers had never set foot beyond its walls for years, he alleged on another occasion.³ Kaganovich also expressed concern in 1935 that, "The isolation of ENIMS from the factories will transform it into a scholastic organisation".⁴ This danger was also noted by the eminent German specialist, Schlesinger, after a visit to the Institute in 1936. ENIMS, he wrote, already had an experimental apparatus "having no equal in the world"⁵; the general concept of research, design and experimental production within a single organisation was ideal, but only on the condition that the research and design staff were deeply immersed in the practical experience of machine tool builders and users, otherwise there was a real danger of the research becoming too theoretical. He clearly believed that ENIMS was in danger of such isolation from practice, and stressed the necessity of regular meetings between design groups and leaders of factories for which designs were intended. This last point was highly relevant because, as another critic noted later, ENIMS had a scientific and technical council which at one time had been a forum for technical debate with factory representatives, but by late 1936 this council had almost expired because, it was claimed, the factories found the discussion too academic.⁶

Representatives of the factories frequently criticised ENIMS's policy in selecting new models, in particular when models based on the products of different foreign firms were chosen for a single enterprise. Such proliferation

1. ZaInd., 29.6.37.

2. Izvestiya, 5.7.35.

3. ZaInd., 17.5.36.

4. ibid., 1.8.35.

5. ibid., 26.9.36.

6. ibid., 29.9.36.

of different designs made standardisation difficult and slowed down assimilation because a large number of original parts was required for each model.¹ Others, notably Shaumyan, criticised the Institute for an alleged lack of activity in developing original designs. One critic in 1937 claimed that ENIMS had not given a single new machine tool design in its four years of existence.² 'Stankokonstruktsiya' was also criticised on similar grounds: Shaumyan and Agapov claimed in 1935 that during its existence it had produced only three surface grinders of a German model of the 1920s and a tool and cutter grinder of obsolete design.³ Some of these criticisms were clearly exaggerated and, in Shaumyan's case at least, appear to have been part of a prolonged vendetta against the leadership of the Institute.

Evidence on the work of ENIMS and 'Stankokonstruktsiya' during the Third Five Plan is sparse. In the autumn of 1939 it was reported that the experimental enterprise was working much better than ever before : whereas only two or four machines used to be built a month it was then producing sixteen, with greatly reduced lead times.⁴ The new director, Maslennikov, claimed in early 1940 that the Institute's work had improved since it had been transferred from Glavstankoprom to NKTyazhmash; formerly it had been unable to resolve technical policy questions satisfactorily because it had been permanently submerged, "in a sea of countless current matters".⁵

In the press of the time the negative aspects of the work of ENIMS tended to be highlighted and its achievements passed over. Despite the many problems and weaknesses, largely stemming from the fact that such large tasks were posed for solution in an extremely brief period of time, the Institute and 'Stankokonstr-
the
uktsiya' undoubtedly made a major contribution to the development of machine tool industry. At the beginning of the Second Five-year Plan design and development forces were few, the possibility of creating original designs extremely

1. *ZaInd.*, 4.2.35; 24.3.35.

2. *Ibid.*, 29.6.37.

3. *Izvestiya*, 5.7.35. Later Shaumyan claimed that 'Stankokonstruktsiya' was taking orders for all types of parts, including spares for Glavzoloto. This was done, apparently, because such orders were more profitable than the factory's basic activity. (*ZaInd.*, 17.5.36; 30.8.35).

4. *Mashinostroenie*, 9.2.40.

limited, and specialised, high-productivity machines could only be built with very great difficulty. By the War the industry was able to build any type of machine tool (even if problems of regular batch production were not completely resolved), and was fully capable of independent design thought. The combination of a central Institute for securing a unified technical policy and solving the most complex problems, and local design and innovation initiative at the enterprises, was on the whole successful. By the end of the period the designers were certainly a much more powerful force, and incentives for innovation were better, but, nevertheless, the problem of securing the regular assimilation of new products and regular design improvements had not been fully solved; the relentless drive for current output remained a powerful force promoting technical conservatism. The tension between current demands for quantity and the demands of technical progress had no easy solution, but it is notable that the intensive innovative activity of the three immediate pre-war years was associated with a reduction of the rate of growth of output in the branch, while quantity demands were met to a greater extent than before by transferring the production of ^{some} basic general-purpose machines from the main specialised enterprises to secondary, often non-specialised, producers.

Returning to the questions raised in Part I of this chapter, how successful was the Soviet machine tool industry in 'catching up and surpassing' capitalist machine tool building in a technical respect? This cannot be answered properly without considering the relative technical level of the Soviet industry at various points in time, and this is difficult because the necessary data are lacking. Adopting the static viewpoint widespread during the First Five-year Plan, there is no doubt that the industry did indeed catch up and surpass the capitalist machine tool building of 1929, and this in itself was a very considerable achievement. But the target moved ahead, imposing ever more intense pressures on the young Soviet industry: not only catching up, but also 'keeping up' became a real problem, and the surpassing moved into the future.¹

1. In early 1935 a *ZaIndustrializatsiyu* editorial declared that the task of qualitatively catching up American machine tool building would have to be fulfilled in "one or two years" (*ZaInd.*, 27.3.35). Others were less rash in their demands and expectations. At a GUSIP meeting in May 1937 Al'perovich was asked, "Will we catch up America in the Third Pyatiletka or only Germany?... No answer was given to this question, because comrade Al'perovich never answers such queries". *Ibid.*, 10.5.37.

Chapter 9THE ROLE OF FOREIGN TECHNICAL ASSISTANCE AND
THE TRANSFER OF FOREIGN TECHNOLOGY

Given the backwardness of machine tool building in the Soviet Union before the First Five-year Plan , the complexity of the technology and the importance of the industry in securing technical and economic independence it is not surprising that interest was shown in the possibility of obtaining foreign technical assistance. Such assistance played an important role in the development of a number of key branches of engineering both before and during the First Plan , notably in the motor industry ,diesel building, the electrical equipment industry and the bearings industry. Assessments of the extent to which the Soviet machine tool industry resorted to foreign assistance vary widely. One of the best Soviet histories of the industry states that : " The machine tool building industry of the USSR took its own course . It was unable to obtain assistance from foreign machine tool firms".¹ A leading Soviet authority on pre-War foreign economic relations is even more emphatic:" In producing new machine tools the Soviet machine tool building industry had absolutely no recourse to foreign technical assistance".² Yet it has been claimed by one recent Western work that the achievements of the Soviet machine tool industry up to 1945 were almost entirely due to foreign assistance. On a scale of one to ten , supposedly measuring the 'degree of technical assistance' , the machine tool industry is given a rating of nine.³ Discussion of this important and interesting aspect of the development of the Soviet machine tool industry is hampered by the inadequacy of published material on the subject , both Western and Soviet. This section will examine the available evidence and it will be shown that , while such foreign technical assistance played a limited but important role during the First Five-year Plan period , it was by no means crucial to the development of the industry.

1.Omarovskii,op cit,p56.

2.Kas'yanenko,V.I., Bor'ba trudyashchikhsya SSSR za tekhnicheskuyu nezavisimost' promyshlennosti , (1926-1932gg),M. 1960,p31.

3.Sutton,A.C.,Western technology and Soviet economic development, 1930 to 1945,
Stanford, 1964, pp330-332.

There is a wide range of possible forms of foreign technical assistance which for our purposes may be classified by the degree of directness of the aid provided. The most direct form is the concession agreement, under which foreign capital and technical and managerial skills are engaged to develop an enterprise or branch of production. Secondly, there are technical assistance agreements under which foreign firms or organisations undertake to fulfil certain specified obligations, e.g. to assist in the planning, construction and assimilation of new production capacity, or to assist in the projection, introduction and assimilation of products or processes. Such assistance frequently involves the transfer of blueprints and other necessary documentation, the training of specialists and workers, and the supply of certain materials and components. Thirdly, there can be licence agreements under which documentation is supplied for the transfer of products and processes developed by foreign firms. Such agreements may not involve any direct assistance in the assimilation of the objects concerned. A fourth form of assistance is the training of personnel by foreign firms and organisations, either abroad or in the recipient country. Finally, individual foreign specialists may be engaged as consultants.

In addition to the abovementioned direct forms of foreign technical assistance there are a number of other, indirect, channels for the transfer of foreign technology and technical knowledge. Firstly, examples of foreign products may be acquired and copied without any direct foreign participation. Secondly, knowledge of foreign technology may be obtained by visits to foreign factories, research establishments, exhibitions, etc. Thirdly, information may be obtained from foreign technical journals, catalogues and other printed materials. In the case of the development of the Soviet machine tool industry all the main forms of foreign technical assistance and transfer of technology were either adopted or seriously considered during the period under consideration. The main forms of assistance, both direct and indirect, will now be discussed. The importation of machine tools, a major channel for technology transfer, will be considered in the following chapter.

Concessions

In July 1928 Sovnarkom, on the basis of a report presented by the concessions committee, Glavkontsesskom, adopted a decree on the activation of concessions policy.¹ On the basis of this decree a list of possible concession objects was drawn up; this included the building of a general machine tool factory with a cost of construction of 9 - 10 million rubles, to be located in either the central industrial region or the South.² Nothing came of this offer. In July 1929 the construction of a machine tool factory in the Urals was being offered as a concession object, with possible alternative locations in the Ukraine or the central region.³ But by this time Soviet policy with respect to concessions was changing and greater emphasis began to be placed on technical assistance agreements. Nevertheless, in a semi-official work published in the United States in 1930 a machine tool factory was still being offered as a possible concession.⁴ There was probably little expectation of success, however, as there was no mention of resort to concessions in Soviet comment and machine tool building policy after 1929.

'Orgametail' and German Technical Assistance

When the decision was taken at the end of the Restoration period to embark on the construction of new engineering factories VSNKh, and Glavmetall in particular, was faced with the problem of projecting these new works, i.e. designing the factories and planning the basic production processes. Initially, from 1926, this work was undertaken for both the metallurgical and engineering industries by Gipromez; later the engineering industry section split off to form a specialised organisation, Gipromash. But project work was also undertaken by the rationalisation organisation, 'Orgametail', founded and headed by E.M. Al'perovich. In the late 'twenties this body was an important channel of foreign technology transfer to the USSR, both with regard to

1. Yufereva, E.V., Leninskoe uchenie o goskapitalizme v perekhodnyi period k sotsializmu, M., 1969, p85.

2. Torg. Prom. Gaz., 12-10-28 (other concession objects included the Stalingrad tractor factory and an aircraft engine factory in the Urals)

3. Ek. Zhizn, 17-7-29 (supplement on economic relations with the USA)

the supply of equipment and the drawing up of projects for new factories and those undergoing reconstruction.

In April 1926 Orgametall reached agreement with the Union of German Machine Tool Builders (Verband Deutscher Werkzeugmaschinenfabrik Ausfuhr Gemeinschaft), usually known as 'Faudewag', for the creation in Berlin of a joint German-Soviet Technical Bureau.¹ This Bureau started work in 1927 with a staff of three: by 1930 it employed over one hundred workers.² It was disbanded in 1931 with the termination of the agreement.³ On a consultancy basis the Berlin Technical Bureau drew on the knowledge and experience of German machine tool and other engineering firms (e.g. Fritz Werner, Krupp, Borsig and Demag), and also individual specialists, notably the eminent machine tool engineer, Prof. G. Schlesinger.⁴ It is claimed that firms were willing to participate in anticipation of securing large orders for equipment for the new enterprises. Between 1927 and 1931 projects drawn up by the Orgametall Berlin Bureau included the Toret'sk bolt factory, a bicycle factory in Moscow, several shops of the Kramatorsk heavy engineering works, a shop of automatic machine tools at the Podol'sk sewing machine factory and an expansion of the Lugansk locomotive works.⁵ Subsequently, the project side of Orgametall's work appears to have been taken over by Gipromash. But most important from our point of view is the fact that the Bureau also drew up the outline projects (*eskiznye proekty*) for the three new machine tool factories built during the First Five-year Plan period, and also for the two large new tools and measuring instruments works, 'Frezer' and 'Kalibr'.⁶

The decision to project the three new factories (turret lathes and semi-automatics (Moscow), milling machines (Nizhni Novgorod), and drilling machines (Khar'kov)) in Berlin must have been taken in the autumn of 1929.

In September 1929 Orgametall was given the responsibility of organising work on the new enterprises⁷ and at the time of creation of Stankotrest the

4. Bron, S. G., Soviet economic development and American business, New York, 1930, p139

1. Torg. Prom. Gaz., 25-4-28.

2. 10 let Orgametalla, M., 1935, p151.

3. ibid, p152.

4. ibid, pp151-152.

construction organisation, 'Stankostroi' was subordinated to Orgametall and not the trust. In January 1930 the project capacities of the three new factories were raised quite substantially necessitating revision of the projects.¹ Nevertheless the projects for the Moscow and Nizhnii-Novgorod factories were received from Berlin on 27th March 1930 and for the Khar'kov works on 2nd May. These projects prepared in Berlin were not fully elaborated blueprints but outline plans. Detail elaboration of the projects and the making of working drawings was undertaken in Moscow by 'Stankostroi'. The completed projects were approved by the Scientific and Technical Council for machine building and metal working of VSNKh at the end of March for the turret lathe and milling machine factories, and the beginning of June for the drilling machine factory.

German specialists participated in the elaboration of the projects for the new factories, which were conceived as assembly-machining units without preparatory shops. Thus it seems likely that Schlesinger was involved in this work and that German machine tool firms were consulted.² The method of drawing up the project was as follows:³ an example of the basic model to be built was acquired, working drawings of it made and, on the basis of an analysis of the parts required, an approximate estimate of the necessary production area and equipment derived. Production was projected to be of a batch type, with a batch size of up to fifty units in the case of the milling and turret lathe factories. Considerable reserves of capacity were provided, partly stemming from an assumption that the machining shops would work on a less than two shifts basis (this was later revised) and partly because large reserves of equipment and area were provided. Equipment was to be of a universal type and, with few exceptions, machines were to use ordinary cutting tools at average cutting speeds, and

5. *ibid*, p152; Kolomenskii, A., *Kak my ispol'zuem zagranichnyu tekhniku*, M., 1930, p34.

6. *10 let Orgametalla*, op cit, p152; *Vestnik metallopromyshlennosti*, 1931, No8, p65.

7. *Izvestiya*, 19-5-30.

1. *ibid*.

2. Some of the broader implications of this German involvement are discussed in Chapter 4.

3. See *Vestnik metallopromyshlennosti*, 1931, No8, pp64-75 for a detailed review of the projects for the new factories.

not the new hard-alloy tools then just entering into use. Later in the 'thirties there were to be accusations that German specialists deliberately incorporated an assumption that Russian workers would not be able to achieve the machine utilisation rates typical of Germany at the time the projects were drawn up.¹ It does seem quite possible that such an allowance was made², but this allowance 'for Russian backwardness', although an affront to the pride of Soviet workers and specialists, in practice provided a reserve of capacity which was to prove of great value later in the decade. No evidence of foreign technical assistance in projecting other new factories (in particular, the Kiev automatics factory and the Saratov gear-cutting machine works) has been traced; and it also appears that the projects for the reconstruction of a number of old machine tool building enterprises were drawn up by Soviet organisations, although it is possible that individual foreign consultants were involved.

American Technical Assistance

While all three new factories were projected in Germany they were planned for the building of American machine tool models.³ This was probably a consequence of what appears to have been a quite general 'turn to America' from the spring of 1929 and, in the course of the year, this interest in American technology led to efforts to secure American technical assistance in many branches of industry. One of the leading advocates of American technical assistance was M. Gurevich, deputy chairman of Amtorg, the Soviet trade organisation in the United States. In a report to the board of Glavmashinstroi at the end of May 1929 Gurevich argued the case for securing American assistance, but was very critical of the practice of Soviet ordering of machine tools from American machine tool firms: American firms were unwilling to enter into talks on technical assistance because they saw no guarantee of receiving large orders for their own products. According to Gurevich it was then normal practice for Soviet machine tool orders to be placed with many firms in very small quantities, say three

1. This accusation was made with regard to the im. Ordzhonikidze factory in 1937 - Mashinostroitel', 1937, No 17, p. 3.; see also Gudov. I. Sud'ba rabochego, M., 1970, pp. 28-30.

to four at a time.¹ In June Gurevich propagated the merits of American technology and assistance in the press,² and ~~and Gurevich~~ presented a report to the VSNKh Presidium³. In his contributions Gurevich stressed that many American machine tool firms were willing to project machine shops in which their equipment was to be installed and that this form of aid had already been employed at the Putilov works and at the Stalingrad tractor factory, then under construction. Furthermore, Amtorg had already opened a project bureau in Cincinnati at which Soviet and American engineers were jointly elaborating projects. But, Gurevich again emphasised, this form of assistance would only be forthcoming if large orders for machine tools were placed with the firms concerned.⁴

This campaign for American technical assistance does appear to have had some impact. VSNKh recommended that a commission should visit Germany and America to discuss technical assistance for the machine tool industry with firms which had been given large orders,⁵ and at some time early in 1930 the board of Stankotrest discussed the possibility of projecting the three new factories in the USA.⁶ This change of policy was probably influenced by NK RKI criticism of Stankotrest on the grounds that it had not secured sufficiently modern consultation; i.e. assistance was being obtained from Germany rather than America.⁷ It is evident that serious discussions did take place in 1930 between the Soviet industry and at least two leading American firms. The content of the technical assistance in question is not known, but probably related to the projection and organisation of production processes and help in the assimilation of new models. The 'Cincinnati' milling machine company was approached with regard to the possibility of providing technical assistance for the Nizhnii Novgorod milling machine factory. According to Soviet accounts 'Cincinnati' were unwilling to cooperate when they learnt of the scale of the new enterprise. The President of the American firm visited the USSR for talks on the project and is quoted as having expressed the view

2. The first director of the Stalingrad tractor factory, Ivanov, in a work published in 1934, admitted without comment that at the factory American rates had been reduced by 20 per cent 'by way of a reserve'. (Ilyin, Y.; Galin, B. Those who built Stalingrad, New York, 1934, p37.)

that it would be impossible to transfer the experience of 'Cincinnati' to the new Soviet factory because Soviet conditions and the envisaged scale would require a quite different approach to production organisation and methods. Doubts were apparently expressed about the ability of Soviet workers to build machine tools using the methods applied in America.⁸ The second known case involved the related firm of 'Cincinnati-Bickford', specialised builders of drilling machines, including a widely used type of radial drill. A modern Soviet history of the Khar'kov drilling machine factory states that technical assistance was discussed with the American firm, but was not taken up because it "... demanded the colossal sum of one million gold rubles for consultation. We had to reject such expensive 'aid'".⁹ It is therefore possible that 'Cincinnati' also offered to provide assistance to the milling machine works but at a price which the Soviet side felt unable to accept.

Despite the failure of the Soviet industry to engage an American firm as a major consultant, it is clear that some assistance was provided. Writing on the occasion of the establishment of diplomatic relations between the USSR and the USA in the autumn of 1933, P. Stepanov, deputy head of the machine tool building glavk, noted that the Soviet industry had special interest in the firm of 'Cincinnati', especially with regard to milling machines and centreless grinders, and that there had been long-standing links with the firm from the days of the foundation of Orgametall. Furthermore, the services of the firm had been employed in assimilating several types of machines at the Gor'kii factory. Stepanov added that there had been technical links with a number of other American firms.¹⁰ This technical assistance may well have taken the form of permission to copy foreign models and supply of the necessary documentation.

3. Nizhnii Novgorod for 'Cincinnati' milling machines (Vestnik Metalloprom., 1931, No 8, p 65); Khar'kov for 'Cincinnati-Bickford' radial drilling machines (Khar'kovskii stankostroitel'nyi, Khar'kov, 1968, p 7); Moscow for Warner & Swasey turret lathes (ZaInd., 29-10-32) and, at first, 'Potter & Johnston' semi-autos. (ibid., 14-4-31), later changed to 'Fay' type (Ek. Zhizn', 22-11-32).

1. Ek. Zhizn', 25-5-29; Torg. Prom. Gaz., 25-5-29.

2. see Torg. Prom. Gaz., 12-6-29 for machine tool industry technical assistance.

3. Torg. Prom. Gaz., 8-6-29.

4. ibid., 12-6-29.

Some Problems of Foreign Technical Assistance

A review of changing attitudes towards foreign technical assistance to the machine tool industry during 1930 and 1931 reveals some of the obstacles encountered and the probable forms of assistance that were obtained. One of the first policy statements on the question was the decree which followed the January 11th VSNKh Presidium on the machine tool industry. This meeting recommended that Glavmashinstroi secure Stankotrest with the necessary means for sending specialists and workers abroad to study foreign machine tool technology and also for employing foreign specialists in the Soviet Union.¹ The significance attached to this measure was indicated by an Izvestiya editorial in May; this considered that the 'basic path' of solving the industry's problems was the training abroad of 'several hundred young skilled workers' to provide the design forces and setters for the new factories, coupled with the inviting of a substantial number of foreign specialists, in particular designers, in order to create a powerful central design bureau in the newly formed machine tool ob'edinenie.¹² In August 1930, M. Kaganovich, referring to the acute shortage of skilled workers in the industry, called for foreign technical assistance and added that any expenditure on it would be rapidly recouped.¹³ This view was reiterated with considerable force by Al'perovich at a session of the VSNKh Presidium devoted to the machine tool industry at the beginning of September. After cataloguing the acute problems facing the industry, Al'perovich pessimistically concluded that: "It is quite obvious that large successes in the technical restructuring of all the factories and the creation of a really firm base of machine tool building can be achieved only on the condition of obtaining foreign technical assistance".¹⁴

5. Zhibarev, P. B., Industrializatsiya SSSR - veliki podvig sovetskogo naroda, M., 1969, p. 277.

6. Industrializatsiya i stankostroenie (Byulleten' Stankotrest), 1930, No 2-3, p. 69.

7. Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, M., 1930, p. 177.

8. Omarovskii, op cit, p. 56; Za Ind., 7-2-31 (Sorokin). The US 'Cincinnati' company had a maximum annual output of 2,200-2,400; at the time of the talks the project capacity of the new factory was put at up to 4,000 units a year (Za Ind., 7-2-31). The head of 'Cincinnati' again visited the USSR in 1932 and saw the new factory. He is reported as having told Al'perovich that it was the best enterprise he had seen in the Soviet Union and that from the point of view of the scope of its production and conditions of work it was the best machine tool factory in the world - (Nashi dostizheniya, 1932, No 6, p. 96). Attempts to confirm these events with the 'Cincinnati' company have proved unsuccessful.

9. Khar'kovskii stankostroitel'nyi, op cit, p. 12.

The Presidium resolved that foreign technical assistance had to be developed.¹⁵ It is possible that the discussions with 'Cincinnati' were a product of this decision.

Acknowledgement of the necessity of obtaining foreign assistance was not alone sufficient to secure it : this required good working relations with the appropriate foreign firms. These relations did exist , but not so much between the machine tool industry and the foreign firms , but between these firms and the import organisation , 'Stankoimport'.¹⁶ This import organisation was an ob"edinenie , operating on a khozraschet basis under Narkomtorg (from November 1930 - Narkomvneshtorg) with the right to plan some aspects of the import of machine tools.¹⁷ The main function of Stankoimport was the buying of machine tools from foreign firms to the order of Soviet industry for a minimum outlay of foreign exchange : it was not directly concerned with the fate of the domestic machine tool building industry. This conflict of interests emerged publicly in late 1930 and early 1931 . In August 1930 Al'perovich called for the transfer of responsibility for handling import claims for machine tools from Stankoimport to Soyuzstankoinstrument.¹⁸ A month later at the VSNKh Presidium this demand was restated. Soyuzstankoinstrument had already outlined various approaches for the use of foreign experience, he claimed , but a basic condition for their realisation was the granting to the ob"edinenie of the right to influence the placing of orders for imported equipment.¹⁹ This demand was not granted. ~~For that purpose~~ Stankoimport

10. ZaInd., 20-11-33.

11. Zhibarev, op cit, p278.

12. Izvestiya, 10-5-30.

13. ZaInd., 24-7-30.

14. ibid, 12-9-30.

15. ibid, 20-9-30.

16. Stankoimport was apparently created from Metalloimport late in 1930 - the exact date of its formation has not been traced.

17. On the creation of foreign trade ob"edineniya and their functions see Vneshnyaya torgovlya Sovetskogo Soyuza, (ed. Mishustin, D.D.), M., 1938, pp66-67.

18. Izvestiya, 9-8-30.

19. ZaInd., 12-9-30.

claimed that it was in fact making the contacts necessary for engaging foreign assistance, but that the opportunities were not being taken up. Writing in February 1931, the chairman, M. Sorokin, stated that, "We know that some American machine tool firms are ready to grant technical assistance for the organisation of production of machines of their designs in the Soviet Union".¹ Sorokin himself had spoken to representatives of these firms; their usual response was, "We are ready to conclude an agreement for technical assistance with a Soviet organisation and to give you the rights, drawings and our experience for the production of our machines. We appreciate that if we do not give you the right you can if you wish copy the machine tool yourself and start to produce it. It is better to help you get production started properly than to let you make mistakes and ruin the reputation of our trademark".² Sorokin also believed that it would be shortsighted if account were not taken of the desire of certain German machine tool firms with long-standing links with Soviet industry to assist the development of Soviet machine tool building. Sorokin concluded with a controversial conclusion: in view of the acute shortage of machine tools and the limitations of the domestic production base why not, Sorokin asked, citing foreign practice, adopt a policy of importing the more complex elements of machine tools and assemble them with Soviet-made simpler elements? Meanwhile, the Soviet industry would strive to replace the imported items, e.g. spindle heads for drilling machines. For Sorokin there was no doubt that, "The sooner the Soviet machine tool industry is reorganised for production cooperation with foreign factories, the more rapidly will it stand on its own feet".³

Sorokin's proposal drew the inevitable response: he was accused of using the arguments of 'wreckers' who liked to air their knowledge of 'the experience of all advanced countries', forgetting that these 'advanced countries' were capitalists and hostile to the Soviet Union. Production

1. ZaInd., 12-2-31.

2. Ibid; see also Machinery, 16-7-31, p490 - "M. Sorokin refers to the visit of a USA machine tool builder to Moscow who had been informed of the desire of a USSR factory to attempt to produce a machine following closely his own line. (cont.p12)

cooperation could not be adopted by the Soviet machine tool industry claimed one S.Botner , because it would increase dependence on capitalist countries and this was unacceptable for strategic reasons.⁴ A month later Al'perovich himself rejected Sorokin's suggestion on the grounds that it would entail enormous dangers of increased dependence for a long period : the basic task of the machine tool industry was precisely to eliminate foreign dependence in the shortest possible time. Soyuzstankoinstrument was interested in obtaining assistance from abroad ,he added , but only in so far as it facilitated the most rapid assimilation of new models. Furthermore , for the previous six months or more the board of the ob"edinenie had been engaged in practical talks with a number of foreign firms on the subject of assistance in the making of new models but , Al'perovich charged , Stankoimport had given no real help and the largest deals with foreign firms continued to be conducted on a narrowly commercial basis without consideration for the interests of the Soviet machine tool industry.⁵ Relations between the two organisations and their heads were evidently very poor and not improved by Sorokin's persistent criticisms of other aspects of the policy and management of Soyuzstankoinstrument.

Shortly after this public clash on technical assistance policy Soviet attitudes to foreign technical assistance in general also began to change. Two stages in policy with regard to technical assistance during the First Five-year Plan can be distinguished. During the first stage from about the autumn of 1929 to the end of 1930 there appears to have been a positive approach and a definite willingness to enter into agreements . An important factor at this time was the willingness of capitalist firms to provide assistance with the prospect of large export orders at a time when the Depression was deepening. The maximum number of foreign technical agreements was a total of 124 attained at the end of 1930, to a total value of 83 million rubles.⁶ From this time on Soviet attitudes seem to have hardened. Fear of

A clear cut and immediate offer of assistance was made : 'Pay me a small royalty, and I will send you blue prints and render you full assistance. This should suit your purpose better than attempting a risky copy of my machine with possible damage to my reputation'. Perhaps this was 'Cincinnati'?

growing dependence was probably a factor and unfortunate experience with a number of agreements may have led to greater caution.⁷ But the main factor was probably the shortage of foreign exchange. The importation of machines and equipment could be readily justified and accounted for, but the intangible and uncertain benefits of technical assistance were more difficult to quantify. In December 1930 concessions policy was reviewed, and in May 1931 the Party Central Committee and STO adopted a decree on foreign technical assistance agreements. The projecting of factories abroad was forbidden and some agreements were terminated.⁸ Between 1931 and 1933 78 agreements were ended.⁹ Thus the climate changed and from May 1931 it became difficult to enter into new foreign technical assistance agreements. Taking account of the strategic importance of the machine tool industry, it seems unlikely that it would have been allowed to enter into any substantial assistance agreement after May 1931 and this supposition is supported by the absence of any further public discussion of the question.¹⁰

Before the change of attitude one foreign technical assistance agreement was established, but never activated. This agreement, signed in December 1930, was between Stankoimport and the Association of British Machine Tool Makers and provided for the supply of British machine tools worth seven million gold rubles during 1931, with a clause stating ABMTM's willingness in principle to supply technical aid if required.¹¹ No applications for assistance under this contract were made before July 1931.¹² Soon after this the credit situation for British trade with the USSR worsened and this, coupled with the new cautious Soviet attitude, probably accounts for the fact that no assistance was provided under this agreement.¹³

4. ZaInd., 14-3-31.

5. ibid., 14-4-31.

6. Kas'yanenko, V.I., Zavoewanie ekonomicheskoi nezavisimosti SSSR (1917-1940gg), M., 1972, p184.

7. ibid., pp185-187.

8. It was presumably this decree which led to the termination of the Orgametall-Faudewag agreement.

9. Kas'yanenko, op. cit., pp188-189.

10. A curious footnote to the discussion on technical assistance and Sorokin's proposal for production cooperation was the revival of the idea of assembling machine tools from imported components in November 1933. In an article on the problem of supplying machine tools to the motor industry M. Orentlikher, then a member of the production-technical sector of NKTP,

The Role of Foreign Specialists and Workers

We have so far considered two direct forms of foreign technical assistance - for the projection of new factories and the assimilation of new machine tool models. A third form of aid, the employment of foreign specialists and skilled workers, may in practice have been more important. The January 1930 VSNKh Presidium called for the recruitment of foreign specialists and throughout 1930 this call was reiterated by Al'perovich and others. In particular there were demands for the employment of foreign designers to man the new Central Design Bureau of the industry, e.g. the 1st June/NKTP Order¹⁹³² called on the foreign department of NKTP to invite 15-20 experienced designers from abroad to assist Stankoob"edinenie.¹ It is clear that a number of foreign specialists were recruited and that they played a significant role during the difficult initial period of the industry's development when the lack of skilled cadres was one of the major bottlenecks. Early in 1933 the Central Design Bureau had a staff of about twenty-five Soviet designers, working alongside ten from Western Europe and a single American. The American designer, Alfred Wasbauer, supervised the design of heavy machine tools and locomotive shop equipment. The high Soviet evaluation of his contribution is indicated by the fact that while the highest salary of a Russian designer was 450 rubles a month and of a German, 600 rubles, Wasbauer received 1,400 rubles and part of his salary was paid in foreign currency.² There were also foreign specialists working for the administration of the Ob"edinenie and Stankostroi.³ At the factory level foreign personnel held key posts at a time when the industry was struggling to master modern production technology with a largely unskilled labour force. The technical director of the new

suggested this path as a means of saving foreign ^{exchange} spent on imports, while new factories for building automatics, grinders and special machine tools were under construction. (ZaInd., 12-11-33) On this occasion the proposal met with no response, either in the form of public criticism or practical measures for its realisation.

11. Machinery, 20-11-30; Izvestiya, 12-12-30; ZaInd., 11-1-31.

12. Machinery, 16-7-31, p494.

13. Sutton, op cit, pp140-143, discusses 'technical assistance to machine tool plants'. He does not refer to the projection of the three new factories in Germany or to the assistance provided by 'Cincinnati' or any other American firm of machine tool builders. He does refer, however, to the Podol'sk factory and to the 'Ilytch' (sic) works of Leningrad, implying that the

im.Ordzhonikidze factory in Moscow at the time of its construction was a German engineer ,Dreigaut.⁴ There was also a foreign specialist (American?) acting as a consultant at the 'Krasnyi Proletarii' factory at the time of its reconstruction.⁵ One of the most acute problems during the years of the First Five-year Plan and the beginning of the Second was the lack of skilled machine setters and toolmakers , especially at the new machine tool factories . It is evident that many representatives of foreign machine tool firms and other foreign workers acted as setters and trainers for Soviet workers. This was the case at the im.Ordzhonikidze factory.⁶ As Soviet workers and specialists acquired the skills of machine tool building, the need for such foreign advisors diminished and at the same time hostility towards them appears to have developed ,so that by the mid-30s the number employed was probably greatly reduced.⁷

Soviet Visits Abroad

A less direct , but very important , means of acquiring knowledge of foreign machine tool building practice was through visits abroad by representatives of the Soviet industry. Such komandirovki were conducted at various levels. At the top , there were occasional visits abroad by the leading figures of the industry. Al'perovich himself , when head of Orgametail , visited Germany and studied the machine tool industry and also went to the United States in 1927. As head of the machine tool industry he visited Britain, together with M.Kaganovich ,the director of ENIMS ,E.Levin , and other leading representatives for the November 1934 Olympia Machine Tool Exhibition.⁸ In the autumn of 1935 , together with Sorokin , Al'perovich again visited the USA and toured a number of machine tool factories.⁹ A delegation of specialists visited the USA in the following year to study machine tool building , including the leading designer ,V.Dikushin.¹⁰

former received technical assistance from Frank D.Chase Inc.,USA ,and the latter , after an earlier agreement with 'Vereinigte Carborundum und Elekt-rikwerke A.G.',undertook an expansion at a cost of over 30 m.r. to produce two models of the German 'Stock' tool grinders,'after the expropriation of the Stock concession'(p143). The Podol'sk factory ,primarily a producer of sewing machines (the former 'Singer' works),did build small ,bench-type turret lathes in the mid-1930s as a sideline, but there is no evidence that the Chase technical assistance (which would have been related to foundry work)

Orgametall representatives regularly travelled abroad both before and after the formation of Stankotrest, e.g. E. Babich studied the German and British industries; the latter was also investigated by a prominent engineer, G. Golovin.¹¹ In 1934 the then head of Orgametall, V. Piterov, visited American machine tool factories.¹² Another prominent representative of the industry who studied foreign practice ~~inadequately~~ was V. F. Oborin, who made an extremely thorough tour of thirty-four British machine tool factories in the autumn of 1931.¹³ Engineers and other specialists at the factory level also went on komandirovki to study foreign practice, although there were complaints that such visits were inadequate in number and that the knowledge acquired could not be applied properly on returning to the USSR. Thus, it was reported in 1934 that only two engineers at the new Gor'kii factory had been abroad and that in general leading figures of the works had a very poor appreciation of foreign practice,¹⁴ while in 1936 the head of the experimental shop of the im. Lenina factory reported that four months spent at British machine tool factories (Asquith, Herbert and Pollard) were being wasted because his shop was being used for regular production and not experimental work.¹⁵ Problems of foreign exchange availability were probably the main obstacle to the extension of such foreign study visits.

From the mid-1930s an additional channel of information about foreign practice was created, in the form of a team of inspectors who visited factories building machine tools to Soviet orders in order to check quality and standards of production and ensure that machines supplied to the USSR met the specified acceptance conditions. This work was handled by the Technical Bureau of

was directly connected with the machine tool building. In the case of the Leningrad factory this was in fact two related enterprises: the 'Il'ich' Works made abrasives and grinding wheels and for this activity had technical aid from the German firm Carborundum Werke (Aralov & Shatkhani, *op cit*, p162). The im. Il'icha works, created from the machine tool building shop of the 'Il'ich' factory in 1934, did build tool and cutter grinders, including 'Stock' and 'Cincinnati' models, but there is no evidence that 30 m.r. was spent on its expansion (according to the Second FYP, 12.3 m.r. were to be spent on capital work for the whole enterprise), while the Stock concession to which Sutton refers existed between 1925 and 1932 for the production and sale of haberdashery (Yufereva, *op cit*, p222) (Sutton, himself, Vol 1, p233, describes the concession as being for button making).

1. SiI, 1932, No 7, p2

Stankoimport, which also acted as a consultancy service on foreign products and methods for Soviet industry.¹⁶ In 1940 alone Stankoimport gathered eighty reports from its inspectors abroad and some of these were reproduced and disseminated throughout industry, while material on the accuracy standards of foreign machines was passed on to the Committee of Standards for use in elaborating domestic machine tool standards.¹⁷

Other Channels for the Transfer of Foreign Technical Knowledge

Komandirovki were a means of acquainting a comparatively small number of Soviet specialists and workers with foreign machine tools and their production. An alternative means of disseminating information and training personnel on a wider basis was through working displays of foreign machine tools in the Soviet Union. This was one of the most significant contributions to Soviet industry of Orgametall and was made possible by its agreement with Faude Wag. The selection of machine tools for display at a special demonstration hall in Moscow was one of the primary functions of the German-Soviet agreement. New premises for this demonstration hall were opened by Tolokontsev and Mezhlauk in November 1928: at the time of opening 157 German machines were on display and 42 American, all the exhibits being in working order.¹⁸ Between 1929 and 1934 a total of 1,200 different machine tools were shown, built by 150 firms.¹⁹ The demonstration hall served as a means of acquainting Soviet engineers, technicians and designers with the latest foreign technology, as a base for undertaking the comparative testing of foreign models in order to select those to be installed in Soviet industry and built by the domestic machine tool industry (later, in the thirties, ENIMS took over much of this work), and as a centre for training machine installers, setters and other workers. This experience of foreign machines allowed Orgametall to develop

2. see Wasbauer, A.M., "Surpass America", *Machinist*, Vol. 77, 27-9-33, pp 613-615 (a detailed account of the work of the Central Design Bureau).

3. e.g. see *Front nauka i tekhnika*, 1933, No 7-8.

4. *Za Ind.*, 20-5-31.

5. *Slavnye traditsii*, op cit, p 111.

6. *Gudov*, op cit, p 60. This practice was widely adopted in the engineering industry; e.g. at the Chelyabinsk Tractor factory at the time of its commissioning in June 1933 there were about fifty specialists and setters of foreign firms supplying machine tools to the works. (*Letopis' Chelyabinskogo traktornogo, 1929-1945 gg.*, M., 1972, p 124).

a specialised machine tool installation service , this being an activity which had previously been carried out by representatives of the supplying firms. By the end of 1934 the special installation shop of Orgametall, created in the previous year , had a staff of 450 , including 250 skilled installers.²⁰

A final channel for the transfer of information about foreign machine tools and their production was the publication in the Soviet Union of foreign technical-economic literature. Many of the articles in the early issues of the Stanki i Instrument (founded in the summer of 1930) industry journal, were translations of material previously published abroad, usually in Germany. Foreign textbooks were translated , and collections of articles from foreign journal published in book form . During the 1920s the staff of Orgametall produced a number of very detailed studies of German machine tool practice²¹; during the 1930s American machine tool technology was widely propagated, with particular emphasis on high-productivity and unit-construction equipment and the benefits to be derived from the specialised production of components and assemblies. Many technical journals of the 'thirties included reviews of the contents of recent foreign publications, many of which were available at factory libraries.

-
7. The deterioration of relations with foreign specialists at the im. Ordzhonikidze is described by Gudov, op cit, p41.
 8. ZaInd., 6-1-35.
 9. ibid, 23-10-35.
 10. Kas'yanenko, op cit, p301; ZaInd., 6-8-36.
 11. Torg. Prom. Gaz., 22-3-28.
 12. ZaInd., 23-6-34.
 13. Vestnik metallopromyshlennosti, 1932, No10, pp56-64; "o11. pp53-56; No12, pp47-49.
 14. Predpriatie, 1934, No19, p7.
 15. ZaInd., 27-10-36.
 16. Vneshnyaya trgovlya, 1937, No2.
 17. Kas'yanenko, op cit, p302.
 18. Torg. Prom. Gaz., 4-11-28; 6-11-28.
 19. 10 let Orgametall, op cit, p29.
 20. ibid, pp35-38. There is a detailed account of the work of Orgametall , with illustrations, in Machinery, Vol. 38, 16-7-31, pp485-490.
 21. e.g. Novosti stankostroeniya v Germanii, M., 1927 (edited by Al'perovich); and Al'perovich, E.M., Levin, E.E., Obraztsovyi zavod, M., 1928 (a very detailed study of the practice of the German Fritz Werner factory).

Copying Foreign Designs

The most important form of indirect foreign assistance was undoubtedly the copying of foreign machine tool designs for Soviet production . As noted above there may have been some direct aid in the form of provision of drawings in some cases, but as a rule the copying appears to have been undertaken independently by Soviet designers and engineers. It was always stressed in contemporary literature that foreign designs were never copied exactly; they were 'translated into Soviet language' as writers termed the process. This translation involved conversion into metric if necessary and the introduction of Soviet standards where appropriate. It is possible that there was also some design simplification to facilitate production, but there is no direct evidence of this. An American specialist, Wasbauer, who worked at the Central Design Bureau in the early 'thirties testifies to the thoroughness with which standards were applied ; contracts drawn up between foreign designers and the Bureau specified that a maximum application of standard details was a requirement , and he observed that a conscientious designer spent "fully half his time poring into thick volumes of standards".¹ Until the Third Five-year Plan at least a very high proportion of all models built by the Soviet industry were based on foreign designs; the origin of some of the main types of machine tools produced in the 'thirties is indicated in Table SA.XV . This shows that the designs copied were almost always of the leading Western firms engaged in the production of each specific type. The policy of copying foreign designs came to be challenged increasingly in the Second Five-year Plan period, usually by young designers and engineers eager to create original new machines, but the leadership of the Glavk and ENIMS generally resisted this pressure, not always with success. In the Third Five-year Plan this constraint appears to have weakened under the new leadership , and a recent work complained that at this time some designers and managers showed excessive self-confidence , manifesting a disregard for the experience of advanced foreign machine tool firms. As a result, in 1940 of new models introduced only 25 took foreign models as prototypes, and

1. The machinist, 27.9.1933, p.614; 13.2.1934, p.148.

a further 12 were modifications of foreign designs; the total number of new types and sizes introduced in the year was 94.¹ This negative attitude towards foreign designs may well have been a factor in the poor fulfilment of the plans for new models at this time. Copying foreign designs was a valuable means of acquiring design and engineering knowledge and experience, provided the economy with the best available types of machines and, above all, saved the time and cost which would have been involved if the industry had attempted to follow an independent design policy from an early date.

Conclusion

This review of the role of foreign technical assistance in the development of the Soviet machine tool industry suggests that the interpretations of neither Sutton, nor Kas'yanenko, are correct. Foreign assistance was predominantly of an indirect type, the most valuable being the copying of foreign designs, generally undertaken independently by Soviet specialists. It is clear that there was always an ambivalent attitude towards more direct forms of assistance: it was recognised that such aid could accelerate the development of the branch, but at the same time there was an evident reluctance to increase foreign dependence even in the short run. Attitudes were most positive in 1930, and while there were bureaucratic obstacles because of the division of responsibility between the specialised machine tool administration and 'Stankolimport', it does appear that foreign firms would have been willing to cooperate if the Soviet industry had made greater efforts to reach agreement. Given that some other branches of engineering of equal, if not greater, strategic importance did enter into quite comprehensive technical assistance contracts at this time, it would probably have been a wise policy to have secured direct technical assistance in the construction of one or two machine tool factories, thereby accelerating their assimilation and facilitating the general learning process. Such a policy could have led to a faster reduction of foreign dependence than was in fact the case. In this respect the ideas of the second phase of the industry's development may have played a role in fostering a negative attitude to foreign machine tool building practice, which could have

1. Kas'yanenko, Zavoevanie..., op cit, p.198.

reduced the commitment to securing foreign technical aid. Thus we can conclude that direct foreign technical assistance to the machine tool industry was much smaller than in some other important branches of machine building, notably the building of vehicles and tractors, and this makes the Soviet achievement all the more creditable. But in retrospect it can also be concluded that the industry should have made greater use of such assistance; and that it did not do so in part reflects the fact that the crucial importance of machine tool building had not been fully appreciated at the time when foreign technical assistance could have been obtained.

Chapter 10

MACHINE TOOL IMPORTS AND THE STRUGGLE FOR ECONOMIC AND TECHNICAL INDEPENDENCE

The role of machine tool imports before 1914 has already been considered: such imports accounted for over four fifths of total machine tool supply and a very substantial proportion of the foreign machines were of German origin. During the years of the War the heavy reliance on imports was retained but the pattern of supply altered, the USA and Britain now playing a larger role. In the pre-Revolutionary period a pattern of trading relationships and institutions was established, an important position in which was occupied by a number of agencies acting as intermediaries between foreign firms and the Russian engineering industry. One of the most prominent agencies was S.G.Martin of St.Petersburg and Moscow, a British firm which handled the trade of most British machine tool firms and also sold German machinery.¹ The share of American machine tool imports rose in the immediate pre-War period, although much of this trade was handled by German firms.² The October Revolution and the subsequent Civil War led to the break up of these institutional arrangements and temporarily disrupted the pattern of Russian machine tool imports.

Machine Tool Imports before 1929

There were virtually no machine tool imports before 1925³; the low level of capacity utilisation, coupled with the existence of stocks of equipment at unused enterprises and uninstalled machines from the War years meant that demand for imported machine tools was extremely small. As capacity was taken up and reconstruction and expansion began in a number of branches imports gradually revived, reaching one quarter of the 1913 level (by weight) in 1926/27. This import trade was conducted under new institutional arrangements. The old agency system and direct contacts between Soviet enterprises and foreign suppliers was replaced by the state monopoly of foreign trade effected through

1. Saul, S.B., "The machine tool industry in Britain to 1914", Business history,

Vol.X, No.1, Jan., 1968, p.37.

2. Iron age, Vol.85, 16.6.1910, p.1462.

3. See table SA.XVI for volume of imports.

the medium of state trading corporations established under a decree of October 1925. For machinery imports, including machine tools, the relevant organisation was Metalloimport, a joint stock company with state capital. Abroad the state monopoly was represented by organisations directly handling negotiations with foreign firms, notably Arcos in Britain and Amtorg in the USA.

In the year 1925/26 Germany again resumed its position as the major supplier of foreign machine tools, displacing Britain ~~and America~~ which had temporarily gained this position after the Civil War. As demand revived the dominant consideration determining the scale and direction of Soviet machine tool imports became the possibility of obtaining credit in a situation of acute shortage of foreign exchange. The first major credit agreement was signed in April 1926 with Germany: the German government undertook to guarantee 60 percent of payments for goods supplied to the USSR to a total sum of 300 million marks. Over half this credit was used for the importation of machinery and equipment¹. This credit agreement led to a very substantial increase in machine tool imports in 1926/27. Contact with the German machine tool industry was facilitated by the agreement between Orgametall and Faudewag.

The raid on the London offices of Arcos in May 1927 effectively halted the sale of British machine tools to the USSR for a period and helped the German industry to obtain a two-thirds share of total Soviet machine tool imports in 1926/27 and 1927/28.² American machine tool builders appear to have been rather cautious in their approach to sales to the Soviet Union, largely as a result of the discouraging stand taken by the US Department of Commerce. The Department urged great caution in accepting invitations to exhibit at the Orgametall demonstration hall, partly on the grounds that there was no protection of patents, trademarks and copyrights.³ Some American firms did take the initiative, however, and trade steadily increased in the course of the 'twenties. At the time of the opening of the Orgametall hall in 1928

1. Torgovye otnosheniya SSSR s kapitalisticheskimi stranami, M., 1938, p.136.

2. See Table SA.XX.

3. Wagoner, op cit, pp.210-214.

forty two American machines were on display, compared with 157 German.¹ Of the other main supplying countries prior to 1929, Austria occupied fourth place after the three leading supplying countries.

In the late 1920s the possibility of acquiring second-hand foreign machines was raised in the Soviet press on a number of occasions. In March 1927 M. Sorokin (then assistant director of Arcos in London) stressed the possibilities arising from the second-hand market on which virtually new machine tools could, he claimed, be purchased for up to forty percent under the usual price. He believed that it would be sensible to adopt a policy of buying such second-hand machines for Soviet industry, "in view of our poverty", until the latest technology could be afforded.² A year later Al'perovich of Orgametall, after a visit to the USA, observed that there were large possibilities for Soviet industry of acquiring almost new, second-hand machines, especially for the motor industry.³ The manner in which the question was raised indicates that it was not then normal practice to purchase second-hand equipment and, in fact, at no time was this policy adopted on any scale, although during the Depression some used equipment was obtained from bankrupt foreign firms.⁴ Apart from an understandable reluctance to install used equipment at a time when the country was industrialising to the last word of modern technology, there was probably an important practical obstacle, in that new machines purchased abroad by the Soviet Union were generally required to have a full complement of spares and fixtures and this would have been difficult in the case of second-hand machines.⁵

1. Torg. Prom. Gaz., 4.11.28.

2. ibid., 7.4.27.

3. ibid., 17.3.28.

4. For example, the Murom 'Stankopatron' factory was equipped with machines from the bankrupt German firm 'Samson Werke' - Lebyachenko, op cit, p.33.

5. Before 1932 spares, fixtures and tools accounted for 20-30 per cent or more of the value of imported machine tools - K voprosu o tekhnicheskikh sdvigakh vo vtoroi pyatiletke, M., 1932, p.110; Ek. zhizn', 11.2.32. The importance of supplying a full set of spares and small tools was also stressed later in the 'thirties - Machinist, 14.2.1934, p.148.

The availability of the German credit led to a rapid and marked increase in the proportion of machine tools in total imports of machinery and equipment, the share rising from 4.1 per cent in 1925/26 to 12.4 per cent in 1926/27¹. But the exhaustion of this credit and the inability of the Soviet government to obtain an extension of the agreement led to a decline in both the relative and absolute scale of machine tool purchases abroad. The statistics normally presented tend to conceal the impact of the German credit. Alternative data for the calendar year, as opposed to the economic year, reveal the exceptional nature of the imports of 1927:

Table 10.1 Metal cutting Machine Tool Imports, 1926 - 1929
('000 rubles of corresponding year)

1926	7,294
1927	22,929
1928	17,385
1929	19,938

Source: Anders, R. Ya, Krizis kapitalisticheskogo mashinostroeniya i import mashin v SSSR, M., 1934, pp. 188-189.

The large imports of 1927 took place at a time when plans for industrialisation were unclear and when there was no coherent technical policy for the engineering industry. It was later admitted that mistakes had been made in the use of the German credits, leading to a significant reduction in the effectiveness of the equipment purchased.² There were additional factors reducing the effectiveness of imported machines at this time. The greater power and higher speeds of imported machine tools could not be fully exploited because Soviet cutting tools of the period were of an insufficiently high quality. Furthermore, the low level of technical culture was such that expensive fixtures were not used and workers were not able to take advantage of the gearboxes fitted to imported machines: most of the machine tools previously employed and almost all those then built in the USSR were then driven by a stepped pulley from overhead shafts and belts.

1. See Table SA.XVII.

2. Aralov, S. I.; Shatkhan, A. S. (eds.), Promyshlennyi import - itogi i perspektivy, M.-L., 1930, p. 24.

Machine tool imports during the First Five-year Plan, 1929 - 1932

The Five-year Plan of machine tool building as seen in 1927 had envisaged a modest rise of imports from 1927/28 to a peak in 1929/30, followed by a sharp decline in 1930/31. But as indicated above, this pattern of imports was not in fact achieved because the large German credit led to an abrupt rise in 1927 followed by a fall in 1928 and a gradual rise in 1929, when machine tool imports failed to reach the 1927 peak. The exact pattern of imports provided for in the Plan as approved in May 1929 is not known, but it is clear that imports were expected to rise again quite strongly before falling towards the end of the Plan period as new domestic capacity came into operation. As the Plan targets for machine building in general were raised in the course of 1929 it became increasingly apparent that machine tool imports and the degree of foreign dependence were destined to increase even more, and, as related above, this pressure led to a number of revisions of the machine tool industry's Plan in order to raise the domestic contribution. Concern over the extent of the expected increase in machine tool imports was heightened by the claims submitted by industry and other sectors: for the year 1929/30 these totalled 50 million rubles¹, or two and a half times the actual imports of 1929. By the end of 1929 fears were being raised of an ever widening gap between machine demand and supply with consequent massive import requirements², and it was this concern which led to revisions in the Plans for the engineering industry, including machine tool building, early in 1930.

The revised Five-Year Plan for machine tool building adopted after the January 1930 VSNKh discussion on the branch envisaged a 64 per cent rise of imports between 1928/29 and 1929/30; a further 36 per cent rise in the following year, but a very small absolute decline in 1931/32. While the final year import target is not known, it was probably at a higher level than that of the initial year.³ Thus the peak year for machine tool imports was to be 1930/31.

1. *Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami*, M., 1930, p177.

2. For example, *Torg. Prom. Gaz.*, 28.11.29, (Gurevich).

3. See p.450, imports taken as needs less output.

During the years 1929 to 1931 there was a certain ambivalence in attitudes to machine tool imports and their growth. With the onset of the economic crisis it became easier to place orders abroad and machine tool imports steadily rose absorbing a mounting share of total foreign exchange outlays. At the same time the proportion of imported machines in total machine tool sales remained extremely unfavourable. While it was recognised that, as the Plan indicated, machine tool imports would have to increase in the short run, there was also concern at the high degree of foreign dependence and this was translated into demands for a more vigorous expansion of the domestic machine tool industry. Leaders of the industry acknowledged, however, that any premature attempt to force Soviet industry to accept domestically built products of inferior quality would have deleterious consequences for industrial productivity. Thus, in July 1930 Al'perovich admitted that the bias of managers in industry towards imported machine tools was in most cases fully justified in view of the importance of quality and this position was echoed by Kaganovich at the Sixteenth Party Congress.¹ But while acknowledging the necessity of a temporary increase of imports, Al'perovich attacked those who used the then current favourable import situation as grounds for delaying the development of the domestic machine tool industry. Machine tool building, Al'perovich stressed, was not simply a matter of supplying individual machines to customers, but a matter of providing fully tooled technological processes for specific components: the lack of a domestic machine tool industry of a sufficiently high level of development accounted for the fact that many projects for new factories had been elaborated by foreign firms. Thus foreign dependence in the machine tool sector was not simply a question of the import of machines as such, but one of the knowledge, skills and experience associated with machine tool technology.²

The true extent of import dependence in 1930 - 1931 was difficult to determine with any accuracy at the time because of the highly unsatisfactory system of ordering imported machines. In September 1930 it was announced that in the year 1930/31 imports would account for eighty per cent of total machine tool supply,³ but examination of claims submitted by managers revealed a very

1. XVI s"ezd VKP(b), sten.otchet, p. 520.

2. Izvestiya, 9.9.30.

3. Ibid., 20.9.30.

widespread practice of overordering as managers strived to ensure that their requirements would be met in full. This practice was condemned in a Central Committee appeal on the third year of the Five-year Plan in September 1930 and criticised by a number of speakers at the First All-Union Conference of Industrial Managers in early 1931. Criticism of this phenomenon was coupled with mounting pressure for the better utilisation of existing foreign equipment so as to minimise demands for new imports.

Machine tool imports in 1930 amounted to 41.5 million rubles, over twice the previous highest level of 1927/28 and almost 4 per cent of total Soviet imports in 1930, compared with 1.9 per cent in 1929.¹ Despite the non-renewal of the 1927 credit agreement Germany remained the leading supplier, with the USA second and Britain third. The following year, 1931, was the peak year of machine tool imports in both value and unit terms. A total of 14,000 units was imported and machine tool imports accounted for 7.7 per cent of total imports. Imports from Germany received a boost from the conclusion of a major new credit agreement in April, which granted the USSR special credit facilities to the value of RM 300 million, with up to 29 months for payment. There was also heightened interest in Britain as a machine tool supplier. Nevertheless, machine tool imports in 1931 were substantially less than even the revised account of needs for the year had indicated² and it became evident during the course of the year that the mounting foreign indebtedness of the Soviet Union was placing increasingly strict limits on the ability of the country to import machinery. The year ended with a substantial foreign trade deficit and a total indebtedness of 1,400 million rubles.³

In the autumn of 1931 a campaign for the better utilisation of imported equipment was instigated by TsKK-NKRKI, a component of which was a survey on the actual situation the results of which were submitted to Sovnarkom at the beginning of October. The main finding of this survey was that at many enterprises expensive

1. See Tables SA.XVI and XVII.

2. At the All-Union Conference of Industrial Managers M. Kagoanovich noted that total claims for 1931 had been 85,000 units, which after critical examination had been cut by half. Domestic production was to be 16,000 units, implying an import requirement of about 26,000 units - *Pervaya vsesoyuznaya konferentsiya...*, op cit, p22

3. Kas'yanenko, V.I., *Zavoevanie*, op cit, p.172, citing *Pravda*, 4.1.34.

imported equipment was lying idle, much of it not even installed: at 183 enterprises surveyed there was unused machinery to the value of 9.9 million rubles, and surplus equipment worth 4.4 million gold rubles.¹ This survey resulted in the adoption by Sovnarkom USSR of a decree on the utilisation of equipment, but vigorous action was not seen until January of the following year. A deterioration of the terms of trade of Soviet exports was one consequence of the Depression, but in November 1931 Al'perovich voiced concern over another aspect of the capitalist crisis which was beginning to influence machine tool imports in a manner necessitating more vigorous development of the Soviet industry. Considerable difficulties had been experienced in recent times, in placing Soviet orders, he wrote, because the production base of the Western industry was being reduced as firms found themselves unable to finance production on a scale necessary in order to fulfil Soviet orders. Furthermore, many leading German and British firms were already fully loaded for a year ahead with Soviet orders leading to very long delivery times and creating additional problems in placing ^{new} orders.²

The final year of the First Five-year Plan opened with a vigorous campaign for a reduction of the foreign economic and technical dependence of the Soviet Union, in particular for the reduction of machinery imports. This campaign appears to have been prompted by a unilateral decision by Stalin and L.M. Kaganovich to sharply cut the machinery and equipment imports planned for 1932. This measure was taken without the necessary preparation and consultation and caused additional problems in assimilating new enterprises.³ In a speech on January 1st Ordzhonikidze set before the engineering industry the task of reducing foreign dependence to a minimum and this was the signal for a mass campaign for import substitution.⁴ On January 8th the paper, Za Industrializatsiyu, called for the formation of 'shock brigades' to cut machine tool imports and soon after it was announced that a number of brigades of 'combatants for economic independence' had been created.⁵ One of the initiators of the campaign was the 'Krasnyi Proletarii' factory, the engineers of which pledged to save almost 300,000 gold rubles by making tooling and components previously imported and also to make a

I. Kas'yanenko, V. I., Bor'ba trudyashchikhsya SSSR za tekhnicheskuyu nezavisimost' promyshlennosti, 1926-1932gg., M., 1960, p. 19; Voprosy istorii KPSS, 1964, No. 11, p. 38.
2. 311, 1931, No. 11-12, p. 1.

number of special machine tools required by the factory.⁶ This campaign, taken up by many enterprises, was also supported by import organisations. 'Stankoimport' issued an appeal to the machine tool and tooling industry calling for an end to the importation of a range of simpler types including hand-fed vertical drilling machines, lathes with stepped pulley drive and machines for sharpening tools. There was also an appeal for a substantial reduction in the volume of spares and fixtures imported: such items accounted for from 20 to 50 per cent of total machine tool imports. Finally, Stankoimport called for the construction of a range of complex, high-productivity machine tools in the Soviet Union as the only means of securing real independence from imports, and pledged to provide maximum assistance in securing equipment necessary to achieve this aim.⁷

Achievement of the aim of reducing machine tool imports in 1932 was aided by external factors. In 1931 the new German credit and improved trading relations with both Britain and America had created a favourable situation for Soviet orders.

It appears that it had been the Soviet intention to buy a large number of machines from Britain in 1932 (according to a British source, at least half the total), because orders were proving increasingly difficult to place in Germany as the credit was exhausted. But the desired scale of imports from Britain was not attained, again because of credit problems: the Soviet authorities required 20 months credit, but the British Advisory Committee on Export Credits felt unable to allow more than 12 months, despite pressure from the British machine tool industry lobby.⁸ Problems which had complicated trade relations with Germany were resolved in the summer of 1932 leading to a new credit agreement in June. In 1932 Soviet purchases from the United States were cut back because of foreign exchange and credit problems, again in the face of sustained lobbying of the Department of Commerce by the machine tool industry which was at the forefront of a campaign for recognition of the USSR and improved credit support.⁹ The outcome of all these problems was that the German share of total

3. *Voprosy istorii KPSS*, 1964, No. 11, p. 40.

4. Anders, *op cit*, p. 169.

5. *Za. Ind.*, 9 and 11.1.32.

6. *Za. Ind.*, 11.1.32.

7. *Ek. Zhizn'*, 11.2.32.

8. *Machinery*, 21.4.32, p. 72.

9. Wagoner, *op cit*, pp. 208-224.

machinery and equipment imports rose to 70 per cent , compared with 47 per cent in the previous year, while the American share fell from 43 per cent in 1931 to 9 per cent in 1932.¹ Total machine tool imports fell in both value and unit terms in 1932 ,although rising somewhat in terms of weight, and in value terms represented over one fifth of total machinery and equipment imports.

Taking the First Five-year Plan as a whole the pattern of machine tool imports was broadly similar to that outlined in the Plan itself and later variants: imports rose to reach a peak in 1931 and then began to decline. Imported machines in total machine tool supply (domestic production plus imports) represented a declining share, falling from about 50 per cent/in 1929 to 38 per cent in 1932,² although the proportion of imported machines in total industrial installations was presumably much greater in so far as imported equipment was directed towards high-priority industrial branches. Some specific problems of machine tool imports during the First Five-year Plan period are considered later in the chapter, including the impact of the Depression and the structure of machines purchased from foreign machine tool firms.

Machine Tool Imports during the Second Five-year Plan, 1933-1937

The situation with respect to machine tool imports at the beginning of 1933 was very different from that of only four years earlier. Domestic production of machine tools had risen almost three-fold in quantity terms and five-fold in value terms; production at two large, modern factories was being assimilated ; new models were being introduced, including lathes, turret lathes, milling machines, boring machines and planing machines of modern design; an administrative structure had been created; and, most important of all, a force of workers, managers, technicians and designers had been created and was rapidly acquiring the skills of machine tool building. During the previous three-four years a number of very large new engineering enterprises had been constructed , but not yet assimilated , so that the first priority in 1933 and 1934 was not the

1. See Table SA.XX.

2. See Table SA.XVII.

introduction of new capacity but the bringing up to full use of already installed equipment. However, it was not possible to immediately curtail machine tool imports. Despite the considerable progress of the domestic industry the range of products was still extremely limited and a number of essential types were not built at all, notably semi-automatic and automatic lathes, gear-cutting machines, radial drilling machines, plano-milling machines, broaching machines, vertical turning and boring machines, most types of grinding machines and a wide range of specialised and special machines used in large-batch and mass production, and precision and heavy engineering. There were also new factories which had not yet been fully equipped, one of the large t being the Chelyabinsk tractor factory.

This contradictory situation accounts for the fact that in 1933 machine tool imports did not fall as sharply as ^{for} other categories of machinery, while the proportion of total imports represented by machine tools remained almost at the 1932 level and the share of machine tools in total machinery imports rose to a quarter.¹ Nevertheless, in value terms machine tool imports in 1933 were less than half those of the preceding year. On 24th February 1933 NKTP issued an order forbidding the import of machinery to the value of 21 million rubles, including such categories as transformers, turbines, boilers, pumps and other industrial machinery, but not machine tools.² Despite this omission, Al'perovich claimed that the industry was taking it into account in deciding to domestically produce a number of types not originally provided for in the annual plan, in particular pipe and coupling machine tools, multi-tool lathes and large milling machines.³

By 1935 it appeared that the Soviet planners' strategy for technical-economic independence had achieved its aim. In 1934 total imports and machinery and equipment imports both fell to the level of the mid-'twenties, while machine tool imports in both value and weight terms fell to below the level of 1926/27. This progress was maintained in 1935, when only 3,374 units were imported,

1. See Table SA.XVII.

2. Za.Ind., 26.2.33.

3. Za.Ind., 1.3.33.

representing a mere 9 per cent of total annual supply. Problems were now arising, however, which threatened to upset this favourable course of development and force the Soviet Union to resort to a higher level of machine tool imports.

The expansion of the main vehicle factories and the building of a major new bearings factory in Saratov, coupled with the expansion of the First State Bearings Factory in Moscow presented a substantial demand for high-productivity machine tools, many of a specialised nature. These projects received considerable publicity from the end of 1934 but, at the same time, there must also have been many less advertised construction projects relating to the aircraft and armaments sectors which required similarly advanced machines in large numbers. The decision to meet a large share of this new demand from domestic production posed a formidable task before the immature Soviet machine tool industry both in terms of quantity, but more importantly in terms of quality, and the very tight schedules fixed by the Party and government proved too difficult to fulfil. Thus, in 1935 the government was forced to authorise substantial imports and a delegation, which included Al'perovich and Sorokin, was sent to the USA to supervise the ordering of the necessary equipment. In 1936 a total of 8,157 units was imported to a value of over 40 million rubles, while the share of machine tool imports in all machinery and equipment imports rose to one third, and in total imports to 13 per cent; the highest proportion yet reached.¹ In 1937 the level of imports fell again, but not to the low point of 1935.

A feature of the machine tool imports of the Second and Third Five-year Plan periods was the instability of the pattern of supply from different countries induced by the complexities of the international situation which characterised the nineteen thirties. The rise to power of Hitler led to a temporary decline in Soviet-German trade which lasted until a new credit agreement was signed in April 1935. This provided for RM 200 million bank credit for five years. This new credit did not prevent the German share of machine tool imports falling to its lowest level since 1924/25 - only 30 per cent of total imports in 1935.

1. See Tables SA.XVI and XVII.

The 'gap' was filled to a large extent by an increase in the share of British machine tool imports. The recognition by the USA of the USSR in December 1933 led to no immediate substantial change in trading relations despite Soviet hopes at the time, but in 1936 the American share rose to one third. During 1936 and 1937 problems of credit led to a very low level of ordering from Britain. The 1935 German credit, however, was devoted to purchasing machine tools to the extent of 43 per cent of its total value¹, leading to a very marked rise in the German share, which reached 72 per cent in 1937. From about 1935 a new factor began to exert an influence on Soviet ability to buy foreign machine tools, namely the lengthening of delivery times as the industries of the major producing countries recovered from the Depression and began to undertake large orders associated with rearmament programmes. With lengthening delivery times, conditions of payment also tended to deteriorate. These new problems were stressed by Aganovich in August 1935 and led to a call for one hundred percent freedom from foreign dependence.² Concern over the extension of delivery times became especially acute from the beginning of 1937: in January it was reported that American delivery times had reached 8 months, whereas two or three years earlier machines could be supplied in only two months.³ By May delivery times for British machines reached 9-12 months and for German machines from 18 months to two years.⁴

The Second Five-year Plan period saw the first Soviet machine tool exports, admittedly on a very small scale. In 1934 a number of machines, including 'Udmurt' lathes, were sent to Turkey⁵, and in subsequent years a small quantity of machine tools was exported to China, Mongolia, Holland, Iran and Turkey.⁶ In the summer of 1935 the spectre of Soviet competition was raised for the first time in Britain. Soviet small tools had begun to reach the Baltic markets and, later in the year, France. One observer was quite certain that cheap machine tools would soon follow: "It is certain that before the next twelve months are past English machine tool manufacturers will be faced with new and formidable competition in many markets, such as Italy, France and Holland".⁷ It is doubtful whether the Soviet industry shared this confidence at this time!

1. Edelman, M., *How Russia prepared: USSR beyond the Urals*, Harmondsworth, 1942, p. 45.

2. *Za Ind.*, 1.8.35.

3. *ibid.*, 12.1.37.

In the final year of the Second Five-year Plan imported machine tools represented only 7.5 per cent of total supply, but this overall share gives an inaccurate impression of the real level of import dependence for two main reasons. First, imported machines went predominantly to heavy industry: in 1936 three quarters of all imported metal cutting machine tools were installed in heavy industry, and a further one fifth in the rail transport sector.⁸ Therefore, it

is probable that the role of imported machines in the engineering industry was substantially greater than indicated, especially in high-priority branches. Second, the overall figure conceals considerable variation in the extent of dependence for different types of machine tools. Table SA.XX provides an approximate scale of import dependence at the end of the Second Five-year Plan period, the scale reflecting quite accurately the degree of complexity of production of various types.⁹ Thus, imports played the largest role in the case of gear-cutting, grinding, broaching machines, and radial drilling machines, but an extremely small role in the case of shaping, vertical drilling, tool and cutter grinding machines and lathes. This table also reveals the considerable Soviet success in mastering the production of turret lathes, milling, planing and boring machines and, above all, automatic and semi-automatic lathes.

Machine Tool Imports During the Third Five-Year Plan, 1938 - 1940

Despite the considerable progress made by Soviet machine tool building ~~industry~~ during the Second Five-year Plan the domestic industry was still not able to meet all the requirements of industry, in particular for specialised high-productivity equipment required by the aircraft and motor industry and in the areas of heavy and precision machine tools, both vital for military production. The demands of the expansion of the defence industries during the pre-war years could not be met by the domestic industry alone, forcing the Soviet Union to resort to substantial imports which accounted for a very high proportion

4. ZaInd., 12.1.37; 26.5.37.

5. Ibid., 14.6.34.

6. See Table SA.XXV.

7. Warwick, A.J., *The Machinist*, 15.6.35, p.297.

8. *Vneshnyaya torgovlya*, 1937, No.2, p.6.

9. See p.567.

imports of total machinery and equipment/(reaching 47 per cent in 1939) and the highest proportion of total imports (18 per cent in 1939) in Soviet history. The share of imported machine tools in total installations nevertheless remained at the low level of 1937: imports as a percentage of total supply in 1938-40 averaged only 7.7 compared with 13.7 in the Second Five-year Plan.

In the Third Five-year Plan period, as before , the general state of relations between the Soviet Union and the three main machine tool supplying countries exerted a major influence on the pattern of trade. In 1938 and 1939 the British machine tool industry made a substantial contribution under a £10 million credit agreement, almost half of which was used for buying machine tools, primarily for the defence industries.¹ Exports from the United States reached their highest level in the pre-War years: in 1938 when they accounted for over sixty percent of total Soviet imports in value terms, and a high level was maintained in 1939. The Soviet Union was thus fortunate in being able to obtain large quantities of American high-productivity equipment at the very time when a major aircraft industry development programme was being executed. The German share in Soviet imports declined sharply, reaching its lowest level in the pre-War period in 1938. A feature of the immediate pre-War years was the large import of precision machine tools from Switzerland, especially in 1935 and 1940.

After the conclusion of the Soviet-German non-aggression pact of August 1939 the situation changed abruptly. An agreement of 19th August provided for the supply of RM 200 million worth of machinery and equipment to the USSR. But while machine tool imports from Germany rose in 1940 they did not do so to the extent desired by Soviet industry. The German machine tool industry was slow in fulfilling Soviet orders; part of the supply derived from Czechoslovakia and not Germany.² One recent Soviet work claims that the USSR purchased 9,274 units of metal cutting machine tools in 1940, compared with a total of 4,589 usually cited and confirmed by the official trade statistics.³ A possible explanation

1. Edelman, *op cit*, p. 46.

2. Sutton, A.C., *Western technology and Soviet economic development*, Vol. 2, p. 345.

3. Kas'yanenko, V.I., *Zavoevanie*, *op cit*, p. 299.

is that the larger total includes machines purchased but not in fact delivered in 1940. With the outbreak of the Second World War the British and French markets were closed to Soviet industry and in the summer of 1940 the American government imposed an embargo on machine tool exports to Russia and Japan. Machines ordered by the Soviet Union accumulated in stores until released after the German attack in June 1941.¹ No information is available on Soviet machine tool imports in 1941. Machine tool supply uncertainty must have created considerable problems for Soviet industry in the three pre-War years and, if circumstances had been more favourable, it is reasonable to assume that imports would have been at a rather higher level.

Having examined the general development of Soviet machine tool imports in the pre-War years we turn to two questions requiring more detailed consideration first, the influence of the Depression and, second, the structure of Soviet machine tool imports during the pre-War Five-year Plans.

The Depression and Soviet Machine Tool Imports

It is usually assumed that the Depression led to a reduction of machinery prices which to some extent compensated for the sharp fall in the prices of primary products that had such a damaging influence on Soviet foreign trade of the First Five-year Plan period. It is extremely difficult to analyse the pattern of price movements for machine tools because of the changing structure of such imports, in particular the varying shares of expensive, high-productivity machinery and of heavy machine tools. Price movements must ^{also} be seen in the context of the credit terms available at any given time. But on the basis of the available (limited) evidence, it appears that, in the case of machine tools, no real benefit was secured in the years of peak imports, 1930 to 1932: price reductions of any real consequences only occurred during and after 1932, until the market revived from 1935, i.e. during the years when Soviet imports were at their lowest point. This does not mean that there were not crucial non-price advantages to be secured during the crisis years, notably in

¹Wagoner, op cit, pp.279-280; Stettinius, E.R., Lend-lease, Harmondsworth, 1944, p.111.

relation to ease of placing orders, short delivery times and the willingness of capitalist firms to trade with the Soviet Union even in cases in which governments attempted to discourage such trade.

Some evidence on price movements is presented in the following table.

This shows the value per unit weight of total Soviet metal-cutting machine tool imports, and the equivalent indicator for British and German exports to the USSR.

Table 10.II

Indices of Value per Unit Weight of Soviet Machine Tool Imports

1929 = 100

	1928	1929	1930	1931	1932	1933	1934	1935
Soviet Imports(total)	72 ¹	100	106	96	80	58	73	59
German Exports to USSR ²	73	100	89	81	73	60	49	79
British Exports to USSR	.	100	86	78	68	72	71	54

. not available

1. 1927/28

2. Including metal-forming machines

Source: USSR - calculated from Table SA.XVI.

Germany - Statistisches Jahrbuch für das deutsche Reich, various years.

Britain - Annual statement of the trade of the United Kingdom., various years.

Similar evidence is not available for the United States, but the value per unit of metal-cutting machine tools built in the USA during the crisis years actually rose, falling below the 1929 level only in 1935.¹ As the above table reveals, prices in 1929 were exceptionally high because of the tense market situation of that year, and if this is taken into account it is apparent that the Depression gave the USSR little benefit in terms of lower prices in the years of peak imports. One reason for this phenomenon is no doubt the fact that far from falling in the Depression, total world machine tool exports actually rose under the influence of Soviet purchases, only declining from 1932 as Soviet demand slackened, to reach a low point in 1934.²

1. Value per unit of machine tools built in the USA rose as follows (1929=100): 1930 - 110; 1931 - 114; 1932 - 112; 1933 - 108; 1934 - 100; 1935 - 99

Calculated from Wagener, op cit, pp.362-363.

2. See Mishustin, D.D., Vneshnyaya trgovlya i industrializatsiya SSSR, M., 1938, p.156.

It appears that relative price differentials between supplying countries did exert an influence on Soviet purchasing policy and that serious efforts were made to minimise foreign exchange expenditures. On a number of occasions throughout the period it was claimed that British machine tools were over-priced in relation to those of other countries. This point was made by Sorokin of Stankeimport in 1931 and by representatives of the Soviet industry at the London Machine Tool Exhibition in 1934; on both occasions the high prices were regarded as an obstacle to buying in Britain.¹ These high British prices partly arose because of the exceptionally high interest and other charges imposed by the Exports Credit Guarantee Department and the banks. In 1932 it was admitted that excess insurance and interest charges inflated the price of machine tools exported to the USSR by up to 20 per cent above normal levels.² American machines were also considered highly priced³, but the higher productivity usually obtained was regarded as adequate compensation. The Soviet side had some countervailing power, however, stemming from the monopoly of foreign trade. It appears that Stankeimport regularly used its monopoly buying power to promote competition between foreign firms for securing Soviet orders. Competition between foreign machine tool firms was explicitly cited as a mechanism enabling Soviet industry to obtain machines for the Gor'kii automobile factory and the Chelyabinsk tractor factory at lower prices than would otherwise have been possible, giving large foreign exchange savings.⁴

In considering the influence of the Depression of Soviet machine tool imports it is of some interest to consider the reverse influence, i.e. the impact of the Soviet market on the machine tool industries of Germany, the USA and Britain during the crisis years. There is no doubt that exports to the USSR played a very significant role during the years 1930 to 1933, as the following table demonstrates. This shows that in 1932 82 per cent of British machine tool exports went to the USSR and 75 per cent of German exports. Many Western machine tool firms

1. *Za Ind.*, 11.1.31; *Machinery*, 16.7.31, p.490; *Engineering*, 15.2.35, p.164.

2. *Machinery*, 24.11.32, p.234.

3. For example, *Torg. Prom. Gaz.*, 31.12.27 (Al'perovich).

4. *Byli industrial'nye*, M., 1973 (2nd edn.), p.81; *Letopis' Chelyabinskogo traktornogo*, 1929-1945, gg., M., 1972, p.79.

Table 10.III

Exports to the USSR as a proportion of total machine tool exports
(per cent of exports by value)

Country	1929	1930	1931	1932	1933	1934
Germany	10.6	22.8	51.1	74.6	63.1	27.3
USA	6.3	40.0	64.7	25.0	10.2	14.4
United Kingdom	4.9	15.1	67.0	81.7	51.6	36.4

Source: Germany - calculated from Statistisches Jahrbuch für das deutsche Reich, various years.

USA - Handbook of the Soviet Union, N.Y., 1936, pp 363-365.

UK - Calculated from Annual statement of the trade of the United Kingdom, various years.

owed their survival during the Depression to Soviet orders and this fact was frankly admitted at the time.¹ As a result, many thousands of skilled workers and specialists were retained in employment and a basis maintained for furthering technical progress and supplying equipment when the economies revived in the mid-'thirties.

There were also other less obvious consequences of the Soviet orders. First, the Soviet industry specified high standards of accuracy and workmanship. A British expert, writing in 1948, observed that; "Russia is a very discriminating buyer and will insist on the highest quality machines at the lowest possible price. Russian quality requirements should not be lightly dismissed as capricious. If the effect of Russian orders on the German machine tool industry between 1925 and 1940 may be taken as an example, large Russian orders may be beneficial to our machine tool trade in the long run by improving design and accuracy of performance and forcing rational production on our manufacturers".² The Soviet import organisations appear to have been thorough in enforcing quality standards; in 1931 and 1932 alone 617 official claims were filed against foreign firms for breach of agreed standards, almost two-thirds of these relating to the German industry.³ Soviet representatives visited supplying firms to check quality

1. The following comments are typical: on Soviet orders to the Cleveland (USA) machine tool industry in 1930 - "Had it not been for these orders, many Cleveland factories would have shut down when automobile orders temporarily stopped" (Cleveland plain dealer, 2.1.30, cited by Bron, S.G., Soviet economic development and American business, N.Y., 1930, p. 53); the annual report of a leading German firm, Reinecker, in 1931 - "The future of our enterprise depends exclusively on the development of business with Russia" (Cited by Anders, ZaInd., 29.10.32) Hilger, cent. next page.

and in some cases an informal quality check was provided by foreign Communists and other sympathetic workers who strived to ensure that the Soviet Union received high-quality products.⁴ It appears that in the early 'thirties inspection procedures abroad were run down with the decline of Soviet imports, but in April 1935 a meeting of interested parties was organised by the Commissariat of Foreign Trade to discuss methods of improving the situation. Following this, a system of inspectors was organised - machines being built for Soviet industry were checked in the course of construction directly at the supplying factories by Soviet representatives. This work was the responsibility of Stankoimport and, later, the machine tool building glavk.⁵

A second major consequence of the Soviet machine tool imports of the Depression period and after was that it helped to foster the production of American-type, high-productivity machines in Western Europe, many of these being copies (with agreement) of American models which the Soviet Union was buying in quantity.⁶ This practice allowed the USSR to buy American machines in Europe at lower prices and on easier credit terms than would otherwise have been possible. Thus, while Soviet industry greatly benefited from the importation of a large quantity of modern machine tools during the First Five-year Plan years, this trade equally benefited the machine tool industries of the capitalist countries by keeping firms in business, maintaining a healthy export market, raising quality standards and fostering the production of products of a high technical level.

the economic attaché of the German embassy in Moscow throughout the 1930s, was quite emphatic that, "If several important German manufacturing firms, particularly in the field of machine tools, weathered the Depression and could be put to work by Hitler in his rearmament efforts after 1933, it was due exclusively to Soviet orders which kept them in business".

(Hilger, G., The incompatible allies, N.Y., 1953, p. 240.)

2. Fearney, L.A., The engineer, Vol. 186, 17.12.48, p. 627.

3. Kas'yanenko, V.I., How Soviet economy won technical independence, M., 1966, p. 122 (in English).

4. Kas'yanenko, V.I., Zavoeevanie..., op cit, p. 170; Byli industrial'nye, M., 1973, pp. 82-83.

5. Vneshnyaya torgovlya, 1937, No. 2, p. 7; Kas'yanenko, V.I., Zavoeevanie, op cit, pp. 284-286.

6. This influence was observed by a Soviet commentator in 1933 - ZaInd., 21.11.33.

The Structure of Machine Tool Imports

Given the weakness of the Soviet machine tool industry, the acute shortage of foreign exchange and the goal of technical and economic independence from the capitalist economies it is of interest to examine the structure of imported machine tools in order to determine the role played by imports and the way in which the scarce valuta was spent. Evidence is far from complete, but it is possible to approximately determine the changing average weight of imported machines, the structure by basic types, and the relative technical level of imported machines compared with those produced domestically. According to the April 1932 Census of metal-working equipment, imported machines during the First Five-year Plan years were installed predominantly in the machine building and metal-working sector, 64 per cent of the total installations in this sector between 1929 and April 1932 were of foreign origin.¹ Some of the new branches created at this time were equipped almost entirely with imported machines; notably the tractor and vehicle building branches, the stocks of which in April 1932 consisted of ninety per cent or more foreign machine tools.² Table SA.XVI indicates the branches of the engineering industry heavily dependent on imported machines during the First Five-year Plan; these branches including the machine tool industry itself.

The structure of imported machine tools by basic types is indicated by Table SA.XVI³. This information is not directly compatible with data presented elsewhere on the structure of domestic output because some categories (notably gear-cutting machines) have been excluded in order to obtain a consistent series, and the structure is shown in value terms rather than physical units. However, the latter difference is not serious: data on the structure of imports in unit terms available for 1936-1938 indicates that the value structure provides a good approximation. Two features stand out; first, the rising share of automatic and semi-automatic lathes, which gradually displaced turret lathes as the Soviet industry successfully assimilated the latter, and, second, the rising proportion of

1. See Appendix 3, p. 461.

2. See Table SA.XVI, p. 574.

3. See p. 569.

grinding machines, reaching almost 30 per cent of total imports in 1938. If the import structure is compared with the structure of domestic production (TableSA.VIII) it can be seen that lathes and drilling machines represented a much lower proportion of total imports, while autos and semiautos and grinding machines and Third represented a much higher proportion. The situation in the Second/Five-year Plan changed to some extent because the Soviet Union was forced to import a wide range of heavy types of machine tools, in particular special lathes, because of the weakness of the domestic heavy machine tool building branch. The shift towards heavier imported machines can be seen clearly from data on the average weight per unit machine tool imported, which reveal that the average weight rose sharply in the course of the First Five-year Plan, fell in the early years of the Second, and then rose strongly, reaching a very high level in 1939:

Table 10.IV The Average Unit Weight of Imported Machine Tools
(tonnes)

1929	1.92	1933	5.10	1937	6.48
1930	2.57	1934	2.61	1938	5.57
1931	3.74	1935	4.02	1939	11.62
1932	5.08	1936	4.33	1940	4.84

Source: Calculated from TableSA.XVI.

The general categories presented in TableSA.XI conceal progressive changes taking place within each type group. As the Soviet industry assimilated the production of ever more complex types the structure of imports correspondingly changed. This can be seen clearly in the case of the lathe group (TableSA.XXII). The share of single tool standard machines fell, as did the share of turret lathes with the assimilation of the im. Ordzhonikidze factory. The share of automatics and such specialised types as wheel lathes and crankshaft lathes rose, however, as did the category 'other types', which embraced primarily special and specialised models. This shift of emphasis from predominantly general purpose types to special and specialised machines, within a period of only about five years, clearly shows the success of the Soviet import substitution policy.

Additional evidence on the structure of imported machine tools compared with domestically produced machines is presented in Table SA.XXIII. The very considerable difference in the structure of installations of Soviet and foreign origin is clearly apparent, the imported equipment showing a marked bias towards such progressive types as automatics, milling and grinding machines. But no less important is the very substantial difference in the technical level of foreign and Soviet machine tools at the time of the First Five-year Plan. shown in Table SA.XXII. The parameters of the Soviet machines refer mainly to the old models built prior to 1932. This table reveals that the average power of Soviet built machines was consistently lower than for imported machines of the same type, while the overwhelming majority of Soviet machines were fitted with stepped pulley drive, rather than a gearbox, and many had no power feed mechanism. But a further important fact emerges from this table; the technical level of imported machines rose sharply in the course of the Plan period, as can be seen from the average power and the share of machines fitted with gearboxes. This was a time when machine tool technology was moving forward as designs were changed to permit the full use of new hard alloy tools. The new machines were generally of greater weight and power and driven through a gearbox from an individual electric motor. This evidence suggests that the Soviet Union was indeed importing the last word of technology available in the capitalist countries.

The role of imported machine tools in raising the technical level of the Soviet engineering industry during the First Five-year Plan period is revealed by Table SA.XVI¹. Those branches experiencing rapid growth with a very high proportion of imported machines had a stock in April 1932 characterised by a very high proportion of special and specialised machines, a relatively high share of automatic and semi-automatic machines, a low proportion of lathes and planing machines and a relatively high proportion of machines installed in a flow-type arrangement. In general, the higher the share of imported equipment, the more progressive the structure of the stock. This evidence, together with

¹. Table SA.XXVI, p. 575.

further evidence on the transition from highly universal to more specialised machines during the First Five-year Plan (presented in Appendix 3), suggests that Granick is incorrect in his assertion that : "General purpose machine tools completely dominated the machine tool imports of the First Five-year Plan".¹

Conclusion

It has been asserted by one Western writer that; "The dependence of the Soviet Union on the West was as great in 1945, as far as machine tools were concerned, as in 1932" , and, further, that, "... for the whole period under consideration (1930-45) the Soviets depended entirely on more advanced countries for imports of machine tools beyond the two simplest types".² (The 'simplest types' being lathes and vertical drilling machines). The evidence presented here demonstrates the absurdity of these claims: by 1940 the Soviet Union had made very considerable progress in freeing herself from foreign dependence with respect to machine tools; the domestic industry could build all but the most complex , special and specialised types and , despite immense demands imposed by defence considerations, imported machines accounted for less than ten per cent of total supply during the years of the Third Five-year Plan.

On the whole the machine tool import strategy pursued from the beginning of the First Five-year Plan was very successful. During the initial period, taking advantage of the favourable circumstances created by the Depression, machine tools were imported on a substantial scale and made a major contribution to the creation of a modern engineering industry during the early 'thirties, providing a basis for rapidly reducing imports of machinery and equipment of all types. Largely on the basis of imported machinery, a base for the domestic production of machine tools was created during the First and Second Five-year

1. Quarterly journal of economics, Vol. 71, No. 2, p. 217, f.n. 4.

2. Sutton, A.C., Western technology and Soviet economic development, 1930 to 1945, Stanford, 1971, pp. 140 & 144.

Chapter 11

Plans, permitting a sharp reduction of imports by 1934¹. By strictly limiting import possibilities, the government forced the domestic industry to build ever more complex types. This import substitution policy meant that foreign exchange resources were devoted to purchasing an ever narrower range of types not yet covered by the domestic industry notably, in the second half of the decade, heavy and precision machine tools, and special and highly specialised models, in particular those required by the defence industries. This strategy led to machine tools forming an increasing share of total machinery and equipment imports, at the same time as the volume of such imports steadily declined.

The realisation of this import policy was seriously complicated by the international relations of the period and by problems of securing adequate credit. These difficulties imposed constraints on the choice of suppliers and heightened uncertainty; these factors probably helping to intensify pressure to reduce machinery imports to a minimum as rapidly as possible. A crucial factor in import policy and practice in these conditions was the monopoly of foreign trade, which allowed the Soviet government to exert strict control over machine tool imports and provided the basis for a strong bargaining position in dealings with foreign firms, to some extent countering the unfavourable trading conditions facing the Soviet Union because of the suspicion and hostility of governments of capitalist countries at this time. Finally, while some Western writers (e.g. Sutton) stress the importance of Western exports and assistance to the USSR as a major factor in industrialisation, in the case of the machine tool industry there was a very definite reverse influence: the Soviet trade of the First Five-year Plan period was instrumental in securing the survival of many machine tool building firms in Germany, Britain and the USA during the years of the Depression - the machine tool branch by its very nature being especially vulnerable in conditions of economic crisis.

1. This reduction was perhaps excessively sharp: a more gradual reduction of machine tool imports in 1933 - 1935, taking advantage of the exceptionally low prices prevailing at the time (in part, of course, a product of the Soviet withdrawal from the market), could have eased the pressure on the domestic industry during the complex period of the transition to new models and the widening of the tipazh.

Chapter 11

THE LABOUR FORCE AND THE DEVELOPMENT OF THE MACHINE TOOL INDUSTRY

Machine tool building in Western Europe and the United States has traditionally been regarded as an activity the success of which is crucially dependent on the existence of a highly skilled force of workers and engineering and design specialists. As Soviet observers frequently pointed out, these skills, coupled with accumulated experience, enabled machine tool firms to build high quality, technically advanced machines even though the machinery and equipment exploited was often old and worn as a result of prolonged under-investment. Most of the leading Western machine tool firms had by the end of the 1920s several decades of practical experience and possessed a body of specialised knowledge frequently relating to a limited range of types of machine tools, or even a single type. When it embarked on the formation of a modern machine tool industry the Soviet Union possessed almost no such body of skills and experience; the early attempts at machine tool building which took place before the Revolution left hardly any legacy in terms of a skilled force of workers and specialists. In this chapter we examine how the Soviet industry tackled the formidable problem of building up a skilled labour force, and the impact of the acute shortage of skills on the path of development of the branch.

The Formation of a new Labour Force - The First Five-year Plan

The only factory with an unbroken tradition of machine tool building in 1929 was the 'Krasnyi Proletarii' works, but even here machine tools were not the sole product, many workers being engaged in diesel engine building. At the Leningrad im. Sverdlova factory continuity was broken by a period of conservation, although a number of experienced workers did return and played a valuable role in training new cadres during the 1920s.¹ The number of workers² engaged in machine tool building at the main enterprises (later entering into the specialised branch) in 1928 totalled a mere 4,170³, while in 1930 there were only two hundred engineers involved in machine tool building in the USSR.⁴ By 1931

1. Borisov and Vasil'ev, *op cit*, pp. 103-104.

2. Following the Soviet terminology 'workers' refers here to production workers only.

the quality of the intake of new workers in terms of skill, age and experience began to decline. The 'Krasnyi Proletarii' factory complained about the unsuitability of new recruits in July 1930; and as an alternative it contracted for the transfer of 150 demobilised Red Army men as a source of potential skilled workers - these men were found to be highly suitable because they were disciplined and a high proportion were Party members.⁵ But, as the Five-year Plan progressed, the main source of new recruits for both existing and newly constructed enterprises became the rural youth. These workers from the country generally lacked any industrial experience, were not accustomed to factory discipline, and a high proportion were illiterate and of a very low general educational standard. The enterprises were suddenly faced with the difficult task of training hundreds of new workers, while at the same time production was being expanded and the transition to new models undertaken.

The nature of the intake of new workers made the problems of the new enterprises particularly acute. At the Gor'kii milling machine factory, for example, in 1932 45 per cent of the workers were from the peasantry⁶, and at the im.Ordzhonikidze works at the end of 1932 half the collective consisted of youths and young girls of between 18 and 23 years of age and only a few months, if any, industrial experience.⁷ Even at the beginning of 1931, i.e. before the real influx of new workers began, 35.7 per cent of all the workers in the branch were under 23 years of age. The number of women in the labour force also rose dramatically: their share of the total increased from 4.4 per cent at the beginning of 1931 to 26.8 per cent by the end of the year.⁸ Although firm evidence is lacking there is little doubt that the average skill level of the labour force declined sharply between 1929 and 1932. In April 1932 the average grade of machine tool operators in the branch was 3.1⁹, and the overall average

3. Kuznetsova, N.V., Bor'ba rabochege klassa za sozdanie novykh otraslei promyshlennosti v gody pervoi pyatiletki (Aftoreferat), M., 1973, p.10.

4. Puchko, A.A., Razvitie stankostroitel'noi promyshlennosti na Ukraine v dovoennyi period, 1917-1940gg. (Aftoreferat), Kiev, 1970, p.18.

5. ZaInd., 5.7.30.

6. Kuznetsova, op cit, p.11. The proportion at the new Moscow tooling factory, 'Kalibr', was very similar, 47 per cent, suggesting that this was a general phenomenon -

7. s'ezd Sovetov, M., 1935, Byulleten' No.5, p.27.

8. Pravda, 20.12.32.

9. Kuznetsova, op cit, p.11.

grade for leading factories in 1932 was at about the same low level, e.g. 'Krasnyi Proletarii' had an average grade of 3.1, workers of the lowest grades, 1 and 2, together with trainees, accounting for 53.4 per cent of the work force¹ and at the im.Sverdlova factory the average grade was 3.08 in 1931.² Evidence for a deterioration of skill levels can be found in the fact that other branches of a not dissimilar nature which grew more slowly during the years 1929-1932 had a higher average skill level in the final year. Thus, for example, while the average grade of machine tool operators in the machine tool industry in April 1932 was 3.1 (64.0 per cent of the stock having been installed since 1929); in the locomotive-wagon branch the average grade was 3.5 (17.6 per cent of machines installed since 1929) and in the branch producing equipment for the fuel and ore extraction industry the average grade was 3.6 (36.4 per cent installed since 1929).³ The shortage of workers of the highest skills was extremely acute. In April 1932 only 88 machine tools of the industry's total stock of 4,849 units were being manned by workers of grades 7 and 8 (i.e. 1.8 per cent), whereas one third of the stock was being manned by workers of grades 1 and 2.⁴

The influx of new workers lacking industrial experience demanded a major training effort, both at the established and new enterprises. Between 1928 and 1932 the number of workers increased by over 9,000, or 3.2 times.⁵ Clearly, thorough training of all these recruits in order to produce skilled workers was out of the question in the short run; resources were lacking and the workers were required immediately for the expansion of current production. Two main forms of labour training were adopted; first, training in factory schools, the so-called FZU schools⁶; second, training on the job. In addition, some training

9. On the eight grade scale. During the 1930s skills in the engineering industry were rated as follows: Grade 1 - unskilled; Grades 2 and 3 - semi-skilled; Grade 4 and over - skilled (Industrializatsiya SSSR, 1933-37, p. 475) (occasionally, 'highly skilled' was used, generally meaning Grades 6, 7 and 8)

1.

2. Borisov and Vasil'ev, *op cit*, p. 147.

3. Oporudovanie metalloobrabatyvayushchei promyshlennosti, op cit, vyp. 2, pp 130-133; vyp. 4, pp 68-69. For the tractor industry (89.8 per cent installed since 1929) the average grade was only 2.9.

4. *Ibid.*, vyp. 4, pp 68-69. In the fuel and ore equipment making branch, for comparison, 5.4 per cent of the stock was manned by workers of grades 7 and 8, and 25.5 per cent by workers of grades 1 and 2.

5. For 1932, see Table 11.1, p. 394.

6. FZU - Fabrichno-zavodskoe uchenie.

work for the branch was undertaken by the Central Institute of Labour. Training in the machine tool industry appears to have been planned and organised more thoroughly than in other branches of the engineering industry. Planned training began in the branch in 1929-30, when Stankotrest allocated 1.4 million rubles for worker training activities.¹ At the First All-Union Conference of Industrial Managers at the beginning of 1931, Kraval', the deputy commissar of labour, noted that the machine tool ob"edinenie was the only one to have a plan for the supply of cadres to new enterprises.²

The basic means of raising the general educational and technical level of workers was the FZU school. By 1930 these schools existed at 'Krasnyi Proletarii' and 'Dvigatel' Revolyutsii' and another was created during the year at im.Sverdlova. In 1931 a total of 1,737 workers was studying in FZU schools of Stankoob"edinenie, rising to 3,361 in 1932.³ At these schools the students received the elements of basic general education and literacy, coupled with training for specific jobs, much of the latter taking a practical form, e.g. the im.Sverdlova school built five lathes during 1932.⁴ As the schools developed some also trained technical workers: in 1932-33 eight designers and twenty-four draughtsmen graduated from the im.Sverdlova school.⁵ Both im.Lenina and 'Samotochka' has a higher form of training centre in the form of school-VTUZy. These centres trained not only highly skilled workers (a three year course at im.Lenina), but also senior managerial cadres who underwent a course of up to seven years.⁶ The 'Komsomolets' factory was again in a different position because it had always been a factory-educational establishment, having been founded in 1909 as an electrical engineering school for training middle-range technical and managerial personnel; machine tool building was at first simply introduced as a means of providing practical experience, and for providing financial support for the school's activities. In the First Five-year Plan 'Komsomolets' trained many technicians and foremen for the branch.

1. Byulleten' stankotrest, 1930, No. 2-3, p. 49.

2. Pervaya vsesoyuznaya konferentsiya, op cit, p. 245.

3. Vedushchaya rol' rabocheho klass v rekonstruktsii promyshlennosti SSSR, M., 1973, (Chapter by N.V. Kuznetsova), p. 140.

4. Borisov and Vasil'ev, op cit, p. 146.

5. ibid.

6. Nashi dostizheniya, 1931, No. 1, p. 33.

The new factories built during the First Five-year Plan period in Gor'kii, Moscow and Khar'kov were in a particularly difficult situation because they lacked a core of at least a few highly skilled workers. Furthermore, in order to start work on completion of construction, workers had to be trained beforehand while on-site facilities were absent. These problems were tackled by gathering together a number of skilled workers from existing factories to provide a nucleus of experienced cadres, and by training the initial intake of workers at the FZU schools of other neighbouring enterprises. Thus a school FZU for 600 students was organised at the 'Krasnyi Proletarii' factory for training workers for the new im. Ordzhonikidze works; and at 'Dvigatel' Revolyutsii' a similar training school prepared workers for the Gor'kii factory.¹ When the toolroom of the Gor'kii works went into operation in advance of the main shops it was used as a training school - each skilled worker trained two or three new workers - while making jigs, tools and fixtures for starting up production.² The Khar'kov factory started work somewhat later than the other two new enterprises. An initial nucleus of workers was formed on the initiative of the city committee of the Party, which encouraged skilled workers from the town to work there; but the main element of the labour force consisted of untrained young people, and for them a FZU school was created at the new enterprise.³

The factory schools alone were not capable of meeting the needs of the enterprises for workers: the influx of workers was too large and factory managers were not prepared to see a large proportion of the workforce leave production for several months or even years while they acquired machine tool building skills.⁴ For these reasons many workers undertook various forms of on-the-job training without time off from production. This training usually involved attaching new workers to more experienced cadres, who passed on the basic elements of production skills while the workers undertook simple, narrowly defined operations. This

1. Vedushchaya rol', op cit, p.140.

2. Nashi dostizheniya, 1932, No.6, p.95.

3. Khar'kovskii stankostroitel'nyi, op cit, pp.11 and 18.

4. In mid-1930 it was reported that at all Stankotrest factories there was strong opposition to workers going on courses - Byulleten' stankotrest, 1930, No.2-3, p.50.

training was supplemented by a wide range of short-term technical courses, seminars and 'circles' which provided a means of inculcating the more theoretical aspects of technical education. During the First and Second Five-year Plan periods a very high proportion of the labour force at all machine tool building factories was engaged in some form of course of this type.¹ From 1933 a system of voluntary technical exams was introduced in the engineering industry in association with the 'technical minimum' system which laid down basic requirements for certain jobs. This was later transformed into a system of compulsory state technical exams which had to be passed by workers manning certain specified forms of equipment.

On-the-job training schemes in the machine tool industry were pioneered by the 'Krasnyi Proletarii' factory, which devised them because of dissatisfaction with the form of rapid training then being provided by the Central Institute of Labour. The TsIT courses took place at special workshops and in six months provided an introduction to a limited range of basic skills. The 'Krasnyi Proletarii' factory claimed that the skill level attained was unsatisfactory - workers from TsIT had to start at only grade 1. On-the-job training provided by the enterprise itself on both a brigade basis, i.e. a group training under an experienced worker, or individually, was found to give superior results: after only four to six months trainees could work independently at basic machining operations on lathes, milling machines, gear-cutting machines, etc., equivalent to grades 1 and 2.² TsIT did assist with labour training in the branch, however, notably at the im. Ordzhonikidze factory, where it organised a training shop. The institute also undertook planning work on the required labour force structure at all three new enterprises.³

The new workers, many of whom had no previous experience of factory life, not only had to be trained in basic skills, but also taught the essentials of factory discipline. The Party, trade union and Komsomol organisations played a large role in combating absenteeism, and other breaches of discipline. At the im. Sverdlova factory, for example, absenteeism was attacked by means of a 'black kassa', a special pay desk for deviant workers, exposing them to public

ridicule. A commonly employed form of social pressure was the 'comradely court' at which workers were judged for infringements of discipline by their colleagues. The usual punishment was a fine in the form of a contribution to charity, but the court could expel workers from the Trade Union.⁴ The factory newspapers which existed at all the machine tool factories also played a major role in cultivating labour discipline and also in disseminating production experience. Finally, the various socialist emulation movements which developed during the First Five-year Plan, notably the 'shock worker' movement, served as a means of raising the level of productive skills and work culture, and provided incentives for acquiring greater skills through such rewards as access to improved accommodation, holidays, bonuses and visits to other enterprises. At the end of 1929 11 per cent of the workers of the branch were involved in emulation activities; by late 1931 almost two-thirds.⁵

In considering this massive training effort an additional factor must be taken into account, namely, the high level of turnover of workers. This turnover made it very difficult for the factories to achieve a stable, rising skill level because many workers, as soon as they had acquired basic skills, moved on to other enterprises which could offer better conditions of employment. At this time these better conditions frequently amounted to access to accommodation and improved canteen facilities. This problem appears to have been especially acute at the new factories which lacked social, cultural and housing facilities. The Gor'kii factory suffered severely in the early years; it was located in an area which already had a number of major engineering enterprises ('Dvigatel' Revolyutsii', 'Krasnoe Sormovo', and the new automobile factory), and lacked its own housing and transport. A representative of the enterprise described in July 1933 how 400 out of 900 workers had left within a five month period; half had gone to the GAZ factory which offered much better conditions of work, so that

1. Vedushchaya rol', op cit, p.141; Borisov and Vasil'ev, op cit, pp.144-145.

2. ZaInd., 10.4.30; Prob.Ek., 1934, No.6, p.132.

3. ZaInd., 5.12.31. TsIT's training work had the backing of M.Kaganovich - at a meeting of the Collegium of NKTP in June 1932 he declared that, "The training of workers by the TsIT method is undoubtedly more effective than the FZU" (ZaInd., 22.6.32).

4. Borisov and Vasil'ev, op cit, p.135.

5. Vedushchaya rol', op cit, p.129.

the machine tool factory found itself simply performing a training function for the larger, first priority enterprise.¹ This problem persisted; in the first eight months of 1934 925 men were taken on at the Gor'kii factory - and 709 left, while engineering and technical workers changed with 'kaleidoscopic rapidity'.² The well-established enterprises also suffered a high rate of labour turnover. At the 'Krasnyi Proletarii' factory in the first half of 1935, of the total workforce of 3,800, one thousand had left and been replaced.³ In this respect the machine tool industry was in a difficult position throughout the period. It required skilled workers, but being a small branch of industry with limited resources compared with other branches also in need of similar skilled cadres (the auto-tractor industry, aviation, locomotive-wagon building, etc.) it was unable to attract workers by offering better housing and social-cultural facilities. Its problems were exacerbated by the fact that, partly because of the high skill requirements, most of the leading machine tool factories were located in cities which had a concentration of large, high-priority engineering enterprises (Moscow, Leningrad, Gor'kii, Khar'kov and Kiev). Thus the specialised machine tool industry had to adapt itself to a situation in which it could not establish a stable labour force of the quality desired. The military machine tool building factories were in a much better situation in this respect. The Tula, Izhevsk, im. Kalinina (Leningrad), Lugansk, Penza and other machine tool building shops were part of very large and well-established enterprises presumably enjoying the best working conditions and possessing a force of workers and specialist of greater skills and experience than at the glavk factories.⁴

One of the most important questions of the strategy of development of the industry, which it is difficult to determine accurately, is the extent to which

1. Stenogrammy - pervogo vsesoyuznogo soveshchaniya po stankostroeniyu, op cit, p.49.

2. Predpriyatie, 1934, No.19, p.7.

3. ZaInd., 15.7.35.

4. This point is confirmed by Aizenshtadt and Chikhachev - the defence factories were able to quickly organise large-scale machine tool production because they had highly skilled machine tool operators and toolmakers and long experience of producing armaments on a mass basis. (p.189).

the supply of labour during the First Five-year Plan was a causal factor in the adoption of the policies of the second phase of the industry's development. Was the adoption of large-serial production with the widescale use of jigs and fixtures a direct response to the structure of skills of the new labour force, or was the policy adopted and found fortuitously to have the additional benefit that workers of low skills could be employed? The problem of resolving this question is that questions of skills and labour supply did not explicitly figure in the policy discussion of 1929 to 1931. It may nevertheless have been implicitly accepted by leading members of the branch, VSNKh and other specialists that the available labour skills imposed certain constraints which had to be taken into account. Fortunately, Al'perovich's views on the wider problem of skills and the development of industry are known and provide a clue to the solution of this problem. In February 1931 at a VSNKh Presidium meeting at which Figatner of VSNKh had expressed anxiety about the apparent widespread lack of concern and action with respect to labour needs and training for new enterprises, Al'perovich drew attention to the following fact: "...to date the opinion has existed that the new factories need an army of highly skilled turners, etc. as was the case for technically backward production. It takes years to train workers of such skills. But now, as a consequence of splitting up the labour process into its simplest elements, it is possible to train workers within weeks or months".¹ Therefore, Al'perovich concluded, attention had to be devoted not to training skilled workers, but training instructors. The policy of splitting up the labour process into its simplest elements was precisely that adopted by the branch in the years /^{when} the influx of new, totally inexperienced workers was at its height. This suggests that considerations of labour skills were indeed a central element of the policies and practice of phase two.

During the second half of the 1920s some Soviet specialists had closely followed the trends of development of production organisation and their impact on labour skills in both Western Europe and the United States. There is no doubt

1. Za Ind., 13.2.31.

that the experience of the Ford factory was influential at this time. At the end of the decade Ford wrote that skills were showing a tendency to rise:" Today the proportion of jobs which can be learned in a week or less is rather small and to learn any of the more complicated production tasks requires a training of from two weeks to a month provided the man has some natural mechanical ability".¹ Statements such as these must have been very encouraging for Soviet specialists - a month plus an allowance for the peasants' lack of 'natural mechanical ability' was a very short time indeed compared with the many years of training and apprenticeship hitherto regarded as essential.² Other aspects of the Ford experience were also relevant; first, Ford had observed that the proportion of very highly skilled workers showed a tendency to rise with the development of flow production; second, that old craft type workers of universal skills were not suited to the demands of modern production - many old workers had had to be dismissed, Ford claimed, because they could not meet the required quality standards.³ New workers were, in fact, preferred, as a 1915 study of Ford methods had observed:" As to the machinists, old-time all-round men, perish the thought! The Ford company has no use for experience in the working ranks, anyway. It desires and prefers machine tool operators who have nothing to unlearn.."⁴ A Soviet work of 1928 accurately summed up these tendencies of modern engineering production since the beginning of the War: there was a general trend towards the elimination of the old, universal craft type worker; the basic mass of production workers were of relatively low skills, performing specialised operations, but at the same time there was a kernel of new highly skilled workers serving as toolmakers, setters, instructors, installers, etc.⁵ These trends were apparent in both the United States and Western Europe, in the latter being associated with the rationalisation movement and the adoption of elements of flow-type production organisation, notably in Germany, but also in Britain and France. Soviet industrialisation took place at a time when the semi-skilled worker had become the dominant figure in engineering production, a fact which greatly facilitated the

1. Ford, H., Moving forward, London, 1931, p. 134.

2. The Ford experience was described in detail in a number of Soviet works of the period, see, e.g. Mikhailov, A., Sistema Forda, M., 1930; Torg. Prom. Gaz., 24.3.29.

3. Ford, op cit, pp. 123; 133-135.

4. Arnold, H.L. and Faurote, F.L., Ford methods and Ford shops, 1915, p. 42, cited by Burlingame, R., Backgrounds to power, N.Y., 1949, p. 473.

assimilation of new, large-scale, modern enterprises.

The fact that workers of limited and narrow skills acquired after only six months training could undertake responsible production operations did not mean, as many Soviet writers of the First Five-year Plan period tended to assume, that this was a desirable state of affairs.¹ Such restricted skills gave no scope for the expression of creativity, for example, the introduction by workers of adaptations to the work process, and meant that all auxiliary processes such as setting up, maintenance, work organisation, etc. had to be carried out by the few highly skilled workers available. During the Second Five-year Plan the view that modern mass and large-serial production permitted mass deskilling was rejected.² However, the important fact was that with such low skilled workers it was, with appropriate work organisation, possible to assimilate and maintain regular production of modern machines on a large-scale basis. And this is what the machine tool industry did during the First Five-year Plan period, the second phase of its development. If in 1929-30 the industry's leaders had accepted the view that machine tools could only be built by highly skilled workers, a view generally accepted in the West at the time, the path of development of the branch would have been fundamentally different.

During the First Five-year Plan years the few highly skilled workers at the enterprises served as instructors, toolmakers and setters. In this work they were assisted by foreign workers, frequently acting as representatives of foreign machine tool firms supplying equipment. A relatively small group of such cadres was able to service many hundreds of inexperienced trainee workers. Thus, at the 'Krasnyi Proletarii' factory of 3,500 workers there were only thirty to forty old cadre workers who served as instructors and setters, while production was effectively in the hands of young low-skilled labour force trained only for specific operations.³ But these older, skilled workers (and specialists) were

5. Ratsionalizatsiya promyshlennosti SSSR, M., 1928, p. 333. See also Lazarev, V., Ekonomicheskoe obozrenie, 1927, Dec., pp. 57-59.

1. A remarkable, extreme example of this position was that of Zernov, a specialist of the machine tool industry - he called for the reduction of mental and physical skills to an absolute minimum in order to provide the fullest possible mobility of labour - Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No. 9-10, pp. 87-89.

2. By M. Kaganovich, for example, at the Seventh Congress of Soviets, 1935 (7 S"ezd sovetov, M., 1935, Byulleten' No. 10, p. 43.)

3. Plan. Khoz., 1933, No. 7-8, p. 52.

not always matched to the demands of large=serial production and the use of modern production technology. It was found at the 'Krasnyi Proletarii' factory, for example, that these workers at times hindered the adoption of fixtures and special tools, preferring the traditional methods of marking out the work.¹ This conservatism also made itself felt at the new im. Ordzhonikidze factory, particularly amongst the technical workers ;for example, there was a long argument before the factory started work between German consultants and Russian engineers about the relative merits of milling machine tool beds over the traditional method of planing - the Russians firmly stuck to planing, and it required a trip abroad before they could be convinced that milling was a progressive and feasible alternative.² Gudov, the leading Stakhanovite of this same factory, describes how later in the decade older workers and specialists, in particular those who had worked abroad, upheld the view that machine tools could only be built by skilled workers and adopted a sceptical attitude to the efforts of the new ,inexperienced workers.³

There is no doubt that the employment of inexperienced and low skilled workers led to considerable wastage and also damage to machines. This was admitted at the time, but appears to have been written off as an inevitable cost of rapid development.

The Labour Force in the Second and Third Five-year Plan Years.

With the adoption of the policy of the third phase of the industry's development in 1933 labour skill requirements rose, as the industry's leaders appreciated at the time. With the expansion of the tipazh , batch sizes were reduced and the single operation workers became inappropriate as machines had to be frequently reset; furthermore, under the new conditions it was no longer possible to apply as many fixtures and special tools. The resolutions of the First All-Union Conference of the industry in July 1933 stressed the vital importance of training

2. ZaInd., 20.5.31 .The then technical director of the factory, a German engineer, Dreigaut, noted with amusement in the Stankostroi newspaper: "... you boldly and decisively struggle against gods and religion, but at the same time you are for planing not milling".

3. Gudov, op cit, p.100.

1. Predpriyatie, 1933, No.12, p.10. The author, Tarlinskii, notes the strength of the old pre-Revolutionary , 'Bromley' tradition at the factory.

workers of scarce trades for the successful realisation of the new policy.¹ Training within the enterprises continued as before, but with a new stress on the mass testing of workers to ensure the attainment of uniform minimum standards. Skills rose, but not as rapidly as desired. Thus, at the im.Sverdlova factory the average grade had reached 3.5 by 1935 (compared with 3.1 in 1931), but the average grade required was by this time 4.58, and over a third of the workforce were undertaking jobs which demanded a higher skill than they possessed.² A high rate of labour turnover hindered efforts to raise skills, leading to a steady flow into the branch of new, young, inexperienced workers. At the leading 'Krasnyi Proletarii' factory towards the end of the Second Five-year Plan the majority of workers were aged between 18 and 25; the oldest head of a shop was under 35; and the average age of workers in the first assembly shop was only 18 years 3 months! In the factory's experimental shop, which relied heavily on worker skills, half the workers were under 19 and only a quarter over 25 years of age.³ In the machine tool and tooling branch as a whole in July 1935 38.6 per cent of the labour force was aged below 23 years, and 27.7 per cent were women.⁴ While many of these young and female workers must have been employed in auxiliary and assembly processes, nevertheless many basic machining operations must also have been performed by workers of this type. It has been estimated that during this period skills of grades 3 and 4 were acquired after three or four years, and of grades 5 and 6 after six to seven years.⁵ Therefore, by about 1935 the new workers who entered (and stayed in) the branch during the First Five-year Plan must have attained a reasonable level of skill (probably grades 3 and 4) and been able to make full independent use of their machines.

The Stakhanovite Movement, developing in the autumn of 1935, undoubtedly played a positive role in the raising of skills and was itself made possible by the training of the previous period and the experience accumulated. The first Stakhanovite of the branch was Ivan Gudov, a milling machine operator of the im.Ordzhonikidze factory, who set a new record on 13th September 1935, just two days after Busygin's record at the GAZ factory - the first Stakhanovite of the engineering industry. By September 1936 29 per cent of the workers of the branch

1. *StII*, 1933, No. 6, p. 4.

2. *Industriializatsiya SSSR, 1933-1937*, p. 432.

were involved, rising to 39 per cent in late 1938.⁶ At first this mass movement took the form of individual records obtained by simple changes in work organisation and by raising the intensity of use of machines. But as the movement widened in 1937-38 it took on new more creative forms. Many new fixtures were created allowing the simultaneous multiple machining of a number of workpieces, multi-tool devices were made and various methods of reducing auxiliary time were introduced, such as rotating tables. Moreover, individual records gave way to collective forms of emulation in the form of Stakhanovite days and weeks of action involving entire shops or factories, and the aim ceased to be simply maximum output, but extended to raising quality and saving fuel and materials. Leading Stakhanovite workers travelled to other enterprises of the branch to disseminate the new methods of work and critically review their practices.⁷ This movement was also associated with a marked increase in labour productivity and, in general, despite some excesses and absurdities⁸, served as an important means of raising the technical and organisational level of the machine tool industry.

During the years 1937 to 1941 the branch's labour supply problem became more acute. The rate of growth of manpower sharply declined, even falling in absolute terms in 1938⁹. One source of loss of able-bodied workers was recruitment into the Red Army: the 'Krasnyi Proletarii' factory lost over 200 men in 1937 alone for this reason.¹⁰ At the same time the demand for highly skilled workers rose greatly as the factories strived to increase the output of complex, high-productivity specialised and special machines and, presumably, the most highly skilled workers of the branch were engaged in this individual and small batch production. The average skill level of the specialised branch continued to rise,

3. Ostrovskii, Z.I., *Ot Bromleya k 'Krasnomu Proletariyu'*, M., 1937, pp.12-14.

4. *Industrializatsiya SSSR, 1933-1937*, p.438.

5. Zinich, *Istoricheskie zapiski*, No.85, 1970, p.39. Pre-War, a worker of grades 3 and 4 could set up his own machine, knew how to operate a number of different types of machine, could read drawings and used tables to determine the correct cutting regime (*ibid*).

6. Ostrovskii, *op cit*, p.78.

7. *ibid*, p.80; *Mashinostroitel'*, 1938, No.12, p.3.

8. On one occasion Gudov fulfilled his shift norm by 1,470 per cent, making sufficient quantity of one component to last ten months! (*Moskva*, 1970, No.4, p.119).

9. ~~See Table 11.1, p.394.~~

10. Ostrovskii, *op cit*, p.41.

reaching grade 4.5 by the War (compared with 4.2 for the heavy machine building commissariat as a whole)¹ But there is evidence that the shortage of skilled cadres became more acute as the Third Plan proceeded, the development of the movement for manning more than one machine by a single operator providing a clear indication of this fact.

The multi-manning movement, a national campaign arising out of the Stakhanovite movement, was pioneered by E.F.Kostenko at the Khar'kov im.Molotova factory, simultaneously with a similar development at Uralmashzavod.² Whereas the multiple manning of automatic machine tools had been widely practised in the engineering industry for a long time, the new campaign was directed towards the multi-manning of general-purpose types requiring operators of high skills. Kostenko himself operated a number of gear-cutting machines, freeing skilled workers for employment elsewhere in the factory. This campaign, which quickly spread to other enterprises of the branch, was a direct response to a shortage of skilled workers which was restricting the growth of production.³

During the Third Five-year Plan another response to the labour force problem was the introduction into the branch of some elements of the technology of the auto-tractor industry. The development of flow assembly at 'Krasnyi Proletarii' and other enterprises is discussed elsewhere; this move was partly inspired by the need to free skilled fitters for other work. Furthermore, high-productivity, specialised machines, including unit-construction types, were adopted in the branch for the first time, a development which was probably aimed at securing the best use of skilled workers. But the striking feature of both the Second and Third Plan periods, in particular the latter, was the continued use of the production organisation and methods of Phase Two - large-serial production of general-purpose machines with the use of a considerable quantity of special tools and fixtures, alongside the smaller scale production of specialised types. This combination served as an effective means of overcoming the skill problem in

1.Zinich, op cit, p.39.

2.Khar'kovskii stankostroitel'nyi, op cit, p.38.

3.Plan.Khoz., 1939, No.11, p.80; Mashinostroenie, 12.1.40.

Table 11.I

The Growth of the Labour Force in the Specialised Machine Tool Industry

Year	Machine tool & tooling industry			Machine tool industry		
	Workers ¹ (1)	ETP ² (2)	Total labour force ³ (3)	Workers ¹ (4)	ETP ² (5)	Total labour force ³ (6)
1932	29,830 ⁴	3,500 ⁴	(41,663)	13,324 ⁵	(1,750)	(18,843)
1933	(29,404)	(3,770)	(41,468)	(13,232)	(1,885)	(18,896)
1934	(35,197)	(4,158)	(49,194)	(15,839)	(2,079)	(22,398)
1935	(40,431) ⁶	(4,901) ⁶	(56,665)	18,500 ⁷	(2,500)	(26,250)
1936	(46,383)	(5,917)	(65,251)	(21,753)	(3,078)	(31,039)
1937	(50,987)	(7,577)	(73,205)	(24,474)	(4,016)	(35,613)
1938	(44,135)	(7,276)	(64,265)	(22,050)	(4,002)	(32,565)
1939	(47,458)	(9,274)	(70,915)	(24,678)	(5,286)	(37,455)
1940	52,163 ⁸	10,386 ⁸	78,088 ⁸	(28,690)	(6,232)	(43,653)

(..) estimate

Notes and sources:

1. Rabochie.
2. Engineers and technical personnel.
3. Including office workers, trainees, and service personnel.
4. SiI, 1935, No. 10, p. 2.
5. Kuznetsova, N.V., *Bor'ba rabocheho klassa...*, op cit, p. 10.
6. Note SiI, 1935, No. 10, p. 2 gives 42,350 workers and 5,067 ETP.
7. *Problemy ekonomiki*, 1935, No. 4, p. 192: Planned number for year.
8. *Istoricheskie zapiski*, No. 85, 1970, p. 9. Number of workers and ETP calculated from total and proportions given *ibid.*, p. 26.

Derivation of estimates

Columns (1) and (2) - From 1940 totals using index given by Zhed', op cit, p. 32:

	1933	1934	1935	1936	1937	1938	1939	1940
Workers	100.0	119.7	137.5	157.4	173.4	150.1	161.4	177.4
ETP	100.0	110.3	130.0	157.0	201.0	193.0	246.0	275.5

Column (3) - calculated, using the relationship for 1940, i.e. workers plus ETP represent 80 per cent of the total labour force.

Column (4) - estimated from the known proportion of machine tool industry workers in total number of workers in the machine tool and tooling industry, i.e. 1932 - 45 per cent; 1935 - 46 per cent. This share must have risen over the period as more enterprises were transferred to the machine tool branch. For the remaining years the following proportions have been taken(%): 1933- 45; 1934- 45; 1936 - 47; 1937 - 48; 1938 - 50; 1939 - 52; 1940 - 55.

Column (5) - The proportion of ETP in machine tool building was certainly higher than in the tooling branch; therefore number estimated from column (2) by taking proportions used in (4), plus 5 per cent.

Column (6) - As column (3); workers plus ETP accounting for 80 per cent of the total labour force.

circumstances requiring a steady growth of output while the tipazh was being rapidly expanded and renewed.

The growth of the labour force in the specialised machine tool industry in the period 1932 to 1940 is indicated (approximately) in Table 11.I. This shows that the total number employed in the branch rose from 19,000 in 1932 to 44,000 in 1940, while the number of engineering and technical personnel increased by 3.6 times, from 1750 to 6,230. Unfortunately, there is no information on the labour force in the 'planned' industry so that the total employment in machine tool building as a whole can only be estimated. A very rough estimate of total employment can be derived by taking the average productivity of the specialised industry in terms of machine tools built per year per person employed and applying this indicator to the total annual output.¹ In 1932 0.39 machine tools were built per person employed in the specialised industry; in 1937 0.44 and 1940 0.64.² From total annual output the following total manpower estimates can be derived: 1932 50,500 ; 1937 110,700 ; 1940 91,500³. The fall in employment in the Third Five-year Plan is quite plausible, given the large productivity increase of the period, and is concealed in the data for the specialised branch because of the addition of several enterprises transferred from other administrations.

1. This can be justified on the grounds that the productivity of the defence industry machine tool producers was probably comparable to that of the specialised branch, while the other producers, presumably of lower productivity, built relatively simpler machine tools.

2. Calculated from Tables 11.I and 58.I.

3. For comparison, the USA machine tool industry in 1939 employed 39,600 people, producing 1.3 machine tools per person employed (Proizvodstvennyi apparat stankostroitel'noi promyshlennosti SShA, M., 1970, p.41 and Wagoner, op cit, p.363)

Engineering, Technical and Managerial Personnel

At the end of the 1920s, at the start of the First Five-year Plan, the machine tool branch experienced a chronic shortage of specialists. Moreover, some of those at the enterprises were removed in 1930 in association with the expulsion of 'bourgeois specialists' that took place both before and after the Promparty trial. The technical director of the im.Sverdlova factory, a leading engineer at the works before the Revolution, was removed, for example, and it appears that specialists were removed from the 'Krasnyi Proletarii' factory.² The first specialised training facilities for machine tool building engineers were organised in 1929, when a special faculty was created at the State Electrical-mechanical Institute im.Kagan-Shabshaya in Moscow.³ In the following year, by a VSNKh Order of 12th July 1930, this faculty was transformed into the Moscow Machine Tool and Tooling Institute, 'Stankin'.⁴ This independent institute trained a wide range of specialists and skilled workers, including designers, on a day release or evening course basis, offering courses of up to three and a half years. 'Stankin' was certainly the first specialised machine tool building higher educational establishment in the world. During the First Five-year Plan its work was hindered by the lack of suitable premises, equipment and staff, and there were complaints that the glavk did not pay sufficient attention to its development. Nevertheless, in 1932 it had over a thousand students, three-quarters on a day basis.⁵ In 1930 additional educational facilities for machine tool builders were provided in Leningrad, where a special faculty was created at the Leningrad Engineering Institute, and in the same year a similar faculty was formed at the Moscow im.Baumana Engineering Institute.⁶ Thus, during the First Five-year Plan a quite impressive basis for training new engineers, designers and technicians was created. In 1940 a second machine tool and tooling institute was opened in Leningrad.⁷

1. Borisov and Vasil'ev, *op cit*, p.107; *ZaInd.*, 13.2.30. The case of the technical director, Rents, (and the director) of im.Sverdlova in early 1930 was given some prominence in the press; Kuibyshev was directly involved and accused Rents of 'wrecking' activities at a meeting of the Leningrad Party and production *aktiv*.

2. This is implied by an article at the time of the Promparty trial, accusing 'wreckers' at the factory of deliberately holding back machine tool building - *Pravda*, 27.11.30.

3. Gmarovskii, *op cit*, p.59.

During the First Five-year Plan years provision was also made for the education of administrative and managerial personnel for the machine tool and tooling industry. Machine tool industry specialists were trained at the Industrial Academies; in 1932 about a hundred were studying.¹ Furthermore, a FON (faculty of special purpose) was established at 'Stankin' for training engineer-administrators for the branch², while middle-range managerial personnel were catered for at the technicums, notably at the 'Komsomolets' factory.

The training effort initiated from 1929 allowed a rapid build up of the numbers of engineering and technical personnel (ETP) in the branch. By 1933 two-thirds of all the specialists in the machine tool industry had graduated from VUZy and technicums during the previous four years.³ At the im.Sverdlova factory alone the number of ETP rose from only 19 in 1928 to 225 in 1932, of whom 95 per cent had been trained in higher educational establishments during the Soviet period.⁴ In 1932 the number of ETP at 'Krasnyi Proletarii' exceeded three hundred.⁵ For the branch as a whole the number of ETP increased by about 2,3 times between 1932 and 1937, reaching about 6,250 in 1940.⁶ In the Ukrainian republic alone the number of ETP in the machine tool industry increased six-fold between 1932 and 1940, from 227 to 1,425.⁷ An indication of the quality of this large intake of specialists is provided by a survey of 5,392 members of the engineering and technical sector of the trade union for machine tool and tooling workers in January 1938. Of the total, 29.1 per cent had completed a course at a higher educational establishment (including 22.1 per cent at VTUZY), 30.3 per cent were graduates of technicums (therefore of lower technical skills), and no less than 40.6 per cent were praktiki. The majority of this force (53 per cent) had over five years working experience. Of the total 11 per cent were women, 23 per cent were full or candidate members of the Party, and a further 8 per cent were members of the Komsomol.⁸ However, a large proportion of the most highly

4. Volkova, R.V., "Deyatel'nost' Moskovskoi partiinoi organizatsii po stanovleniyu i razvitiyu stankoinstrumental'noi promyshlennosti v gody pervoi pyatiletki, 1928-1932gg", in Istoriya KPSS -Marksizm-Leninizm v deistvie, M., 1974, p.149.

5. SI, 1932, No.4, p.24.

6. Omarovskii, op cit, p.59.

7. ibid., p.60.

8. ibid.

During the First Five-year Plan years provision was also made for the education of administrative and managerial personnel for the machine tool and tooling industry. Machine tool industry specialists were trained at the Industrial Academies; in 1932 about a hundred were studying.¹ Furthermore, a FON (faculty of special purpose) was established at 'Stankin' for training engineer-administrators for the branch², while middle-range managerial personnel were catered for at the technicums, notably at the 'Komsomolets' factory.

The training effort initiated from 1929 allowed a rapid build up of the numbers of engineering and technical personnel (ETP) in the branch. By 1933 two-thirds of all the specialists in the machine tool industry had graduated from VUZy and technicums during the previous four years.³ At the im.Sverdlova factory alone the number of ETP rose from only 19 in 1928 to 225 in 1932, of whom 95 per cent had been trained in higher educational establishments during the Soviet period.⁴ In 1932 the number of ETP at 'Krasnyi Proletarii' exceeded three hundred.⁵ For the branch as a whole the number of ETP increased by about 2,3 times between 1932 and 1937, reaching about 6,250 in 1940.⁶ In the Ukrainian republic alone the number of ETP in the machine tool industry increased six-fold between 1932 and 1940, from 227 to 1,425.⁷ An indication of the quality of this large intake of specialists is provided by a survey of 5,392 members of the engineering and technical sector of the trade union for machine tool and tooling workers in January 1938. Of the total, 29.1 per cent had completed a course at a higher educational establishment (including 22.1 per cent at VTUZY), 30.3 per cent were graduates of technicums (therefore of lower technical skills), and no less than 40.6 per cent were praktiki. The majority of this force (53 per cent) had over five years working experience. Of the total 11 per cent were women, 23 per cent were full or candidate members of the Party, and a further 8 per cent were members of the Komsomol.⁸ However, a large proportion of the most highly

4. Volkova, R.V., "Deyatel'nost' Moskovskoi partiinoi organizatsii po stanovleniyu i razvitiyu stankoinstrumental'noi promyshlennosti v gody pervoi pyatiletki, 1928-1932gg", in Istoriya KPSS - Marksizm-Leninizm v deistvie, M., 1974, p.149.

5. SiI, 1932, No.4, p.24.

6. Omarovskii, op cit, p.59.

7. ibid., p.60.

1. ibid.

2. Industrializatsiya severno-zapadnogo raiona v gody vtoroi i tret'ei pyatiletok, L., 1969, p.432.

skilled specialists worked in the Glavk apparatus and in management posts at the enterprises rather than in the actual production shops. Thus of the 701 ETP with higher education in Glavstankoprom in late 1939 (after the division of the Glavk, therefore excludes Glavtyazhstankoprom and ENIMS), 210 worked in the factory shops, 114 in design offices and 367 in the Glavk apparatus, factory administrations and other organisations.⁹

Despite the rapid growth of the force of specialists the branch appears to have suffered greatly, in particular during the early years, from a shortage of technical skills. Measures were outlined by NKTP at various times in order to improve the situation. The June 1932 Order provided for the direction of VUZy and Industrial Academy graduates to Stankoob"edinenie (and also instructed the personnel sector of NKTP to stop recruiting the branch's specialists for other work).¹⁰ In June 1933 the NKTP Order provided for an improvement in the work of Stankin, with the allocation of new premises¹¹, and in January 1934 NKTP ordered its sector of cadres to transfer 100 young specialists graduating from VUZy in 1934 to GUSIP for design work.¹² But in the 1934 to 1936 period there were many complaints about the weakness of the industry's design forces as a major factor holding back the development of the branch. Al'perovich noted in April 1934 that there were 400 designers in design offices of the Glavk; this number was completely inadequate, he stressed, and called for the transfer of specialists from the auto-tractor branch or rather, as he wryly observed, their return, because 'tens' of engineers and technicians 'some years ago' had been transferred from the machine tool industry to the auto-tractor branch.¹³ Late in

3. Brover, I.M., *Ocherki razvitiya tyazheloi promyshlennosti SSSR*, Alma Ata, 1954, p.127.

4. Kas'yanenko, V.I., *Bor'ba trudyashchikhsya...*, op cit, p.29.

5. *Kollektivnyi dogovor zavoda 'Krasnyi Proletarii' na 1933 god*, M., 1933, p.3.

6. See Table 11.I.

7. Puchko, op cit, p.19.

8. *Industrializatsiya SSSR, 1933-1937*, p.507.

9. *Industrializatsiya SSSR, 1938-1941*, p.229.

10. *SI*, 1932, No.7, p.2.

11. *ibid*, 1933, No.6, p.3.

12. *ibid*, 1934, No.3, p.2.

13. *ZaInd*, 26.4.34.

1935 it was reported that over one third of the graduates of Stankin were going to branches of industry other than machine tool building¹. Thus, the branch seems to have had problems in attracting and retaining specialists as well as workers.

Until 1937 the leading cadres of the Glavk were predominantly engineers associated with Al'perovich from his days in Orgametall. The backgrounds of these workers is not known, but it seems probable that many of them, like Al'perovich himself, received their technical education before the Revolution. Al'perovich graduated from what later became the Moscow Higher Technical School in 1914, and was 41 years of age when he became head of Stankotrest in 1929. After Al'perovich's removal in 1937 the leadership of the Glavk appears to have changed several times before the creation of the Peoples Commissariat of Machine Tool Building in June 1941, when A.I.Efremov took over the leadership of the industry. Efremov had a remarkably rapid rise to prominence; in 1935 he graduated from 'Stankin' and was made a foreman at the im.Ordzhonikidze factory, then rose to become a shop head and, in 1937, first, chief engineer and later, in August, director. In 1939 he was deputy NarKom of heavy machine building, and in April 1940 he took over from Malyshev as NarKom.² The deputy head of GUSIP responsible for the tooling industry, P.M.Stepanov, held his post for at least five years until his removal in March 1937. E.E.Levin, a former Orgametall engineer, held the post of first director of ENIMS from 1933 to mid-1937; but the next director, I.F.Maslennikov, appears to have been a Soviet trained worker from one of the enterprises.³ Little is known about other leading figures of the Glavk, except that its chief engineer towards the end of the Second Five-year Plan was V.G.Lapin, a leading technical worker of the Bryansk Locomotive factory before the Revolution, later chief engineer of AMO, and one of the first technical directors of the GAZ factory.⁴ In mid-1937 one of the charges against the Al'perovich leadership was that it had an incorrect personnel policy, in so far as reliance was placed on people it had known a long time, moving them from post to post rather than promoting new people.⁵ There appears to be some justice in this charge: an ex-Orgametall group and its associates dominated the branch in its

first six to seven years and this seems to have led to distinct career frustration for a new generation of Soviet trained specialists, a number of whom were prominent in the attacks on the Glavk and its leadership in 1936-37 and survived the tragic events of 1937-38, (for example, Shaumyan, Shifrin and Boguslavskii).

During the period 1929 to 1941 turnover of factory directors was quite rapid. The 'Krasnyi Proletarii' factory had at least six directors between 1930 and 1940, the longest surviving occupant of the post being P. Zhbakov.⁶ The im. Sverdlova factory had a succession of different directors in the late 1920s until A. M. Kalashnikov, a former seaman, was appointed in mid-1931 and remained at the post until 1937. During the Third Five-year Plan this factory was headed by I. Chuikov, a son of a poor peasant, educated at a Rabfak and then the Leningrad Polytechnical Institute, rising to director of the 'Pnevmatika' factory before taking over at im. Sverdlova.⁷ The new im. Ordzhonikidze factory had at least five directors between 1932 and 1939; the most interesting appointment⁸ being that of Z. G. Sushkov in 1935. Sushkov studied at the Institute of Red Professors and after a period of travel abroad became head of the foreign department of NKTP and a member of the Commissariat's Collegium. He became director of the factory, despite his lack of technical and industrial experience, at Ordzhonikidze's personal insistence and presided over a very successful period of its work; he was removed in 1937.⁹ In the 1937-38 period the directors and chief engineers of almost all the main enterprises were replaced, many before the downfall of Al'perovich in the summer of 1937, the only traced exceptions being the director of the Gor'kii milling machine factory, Titov,¹⁰ and Gushchin of 'Samotochka'.

1. Plan, 1935, No. 12, p. 12.

2. Khavin, A. F., Kratkii ocherk istorii industrializatsii SSSR, M., 1962, p. 307; ZaInd., 20.8.37; Mashinostroenie, 4.10.39; 18.4.40.

3. Industrializatsiya SSSR, 1938-1941, p. 227.

4. Byli industrial'nye, M., 1973, p. 75; Direktor - I. A. Likhachev, M., 1971, p. 46, ZaInd., 18.4.37.

5. SiI, 1937, No. 12, p. 3.

6. From incomplete information the following have been identified: 1930 - Izakov; 1931 - Legenchenko; 1932-37 - Zhbakov; 1937 - Lapin; 1938 - Chelyshev; 1939 - Taranichev.

7. Borisov and Vasil'ev, op cit, pp 195-196.

8. The following have been identified: 1932 - Arsent'ev; 1932-35 - Gushchin; 1935-37 - Sushkov; 1937 - Efremov; ? - 1939 - Osharov.

9. Gudov, I., Sud'ba rabochego, op cit, p. 49; ZaInd., 21.11.33.

10. Titov is known to have been director in 1934 (Predpriyatie, 1934, No. 19, p. 5) and in 1939 (SiI, 1939, No. 9, p. 4).

After 1937 there were some very rapid promotions and the case of Efremov is by no means unique, e.g. Lyul'chenko was in 1936 the head of the experimental shop of the im. Lenina factory; in September 1939 he is known to have been its director, and in November of the same year he appears as head of Glavstankoprom.

Generalising from the above, it is clear that turnover was at quite a high level during the First Five-Year Plan, much less during the Second, and again very high during the 1937-1941 period. This rapid turnover of factory leadership must have had a deleterious affect on enterprise operation and morale, and made long term planning and projects difficult to realise.

Conclusion

The rapid development of the machine tool industry began at a time when skills of both workers and specialists were in extremely short supply. Nevertheless, the planners and branch leaders did not adapt the rate of growth of the branch to this bottleneck but, in moving forward, adopted a strategy of development such as to minimise the negative consequences of the paucity of skills and experience. In a very short time a large force of workers was trained to a minimum level adequate for the demands of large-serial production of modern general-purpose machines, and by the end of the Second Five-year Plan the branch had a substantial kernel of skilled and experienced machine tool builders. At the same time the rather slower process of educating engineers, designers and technical workers was undertaken with great vigour from the earliest period so that by the end of the decade a new generation of Soviet trained specialists occupied the leading positions in the branch apparatus and at the enterprises. This process of training workers and specialists was attended by substantial cost in terms of poor quality production, design, engineering and managerial errors and other shortcomings, but the sceptics were refuted; the skill bottleneck was overcome and the vital precondition for the independent development of the industry successfully created.

Chapter 12INVESTMENT AND CONSTRUCTION IN THE MACHINE TOOL INDUSTRY

The original First Five-year Plan as adopted in the spring of 1929 allocated 25 million rubles for the construction of two new machine tool factories; one in Moscow with a cost of 15 million rubles and one in Khar'kov worth 10 million rubles.¹ This plan was short lived. By the end of the year the Gor'kii milling machine works had been added and early in 1930 the capacities of all three new factories were revised upwards. The final investment target for the five years is not known: in view of the rapidity with which intentions changed in 1930 there may not have been one. According to the projects of the three new factories, details of which were published in 1931, investment in these enterprises alone was to total about 51 million rubles, excluding housing and other auxiliary items.² By 1932 the value of these projects had been raised: investment in the Gor'kii factory was to total 30 million rubles and in the Moscow turret lathe works 26 million rubles.³ At the same time major reconstructions were planned for all the existing factories which entered the specialised industry in 1929 and 1930.

It is evident that investment plans were cut back very sharply in the course of 1930 and 1931. The Khar'kov works was started and then very soon put into conservation until the Khar'kov tractor factory and the other two new machine tool factories had been basically completed in 1932.⁴ In August Al'perovich expressed alarm at the fact that VSNKh was then intending to invest only 42 million rubles for reconstruction and new construction in 1930-31, although he believed that 105 million rubles would be necessary if plans were to be fulfilled.⁵ Furthermore, he also revealed that 14.5 million rubles had been required for building the three new factories in 1929-30, but only 7.5 million rubles had materialised. This situation led to increasing bitterness on the part of Al'perovich and it seems possible that there was some upward revision of plans for 1931 following the September VSNKh Presidium meeting on the branch. The 1931 plan provided for 95 million rubles worth of investment in the machine tool and tooling

1. Pyatiletnyi plan narodno-khozyaistvennogo stroitel'stva SSSR, 1929, 2nd. edn., Vol. 1, p. 46.

2. Vestnik metallopromyshlennosti, 1931, No. 8, p. 73.

industries (Soyuzstankoinstrument); in fact 65.2 million rubles were allocated.⁷ In 1931 and 1932 work started on three new projects, 'Stankopatron', 'Stankolit' and 'Stankokonstruktsiya'.

Actual investment in each year of the Plan period is indicated in Table 12.I. The scope of the data in terms of enterprises covered is not known. As can be seen investment in the branch rose each year in the prices prevailing, and as a proportion of total investment in machine building represented about two per cent. The actual total invested in machine tool building may have been somewhat larger, because post-War sources given a figure of 113.2 million rubles.⁸ Of the total 50 million rubles was devoted to new construction⁹, including 36 million rubles on the Gor'kii and im.Ordzhonikidze factories.¹⁰ The share of the industry in total investment in new construction during the Plan period was rather larger than its share overall, amounting to 2.9 per cent, compared with 45 per cent for the auto-tractor industry, 18.7 per cent in heavy engineering and 7.8 per cent in the agricultural machinery industry.¹¹ The machine tool and tooling industries together accounted for 5.1 per cent of all investment in new construction in machine building in 1931 and 6.2 per cent in 1932.¹² Thus the machine tool industry accounted for a very small share of total investment during the First Five-year Plan.

Construction of the Gor'kii and Moscow factories began in the summer of 1930 and both entered their starting up period in December 1931, building their first machine tools in 1932 even though construction was in fact far from complete. A feature of the First Five-year Plan period was the manner in which the final project capacities of these new enterprises, and also the older factories, was progressively pushed up; the extent of the increase providing a good indication of the degree of optimism of the period with regard to future output possibilities. The extra output was to be obtained not by additional investment, but by greater

3. *Machinery*, 21.1.32, p.533.

4. *Khar'kovskii stankostroitel'nyi*, op cit, p.8.

5. *Izvestiya*, 9.8.30.

6. See, e.g. *ibid.*, 9.9.30.

7. *Metall*, 1931, No.1, p.3; *Sotsialisticheskoe stroitel'stvo*, M., 1936, pp.388-389.

8. *Omarovskii*, op cit., p.55.

9. *Planovoe khozyaistvo*, 1933, No.7-8, p.21.

use of shift work and other measures for making more intensive use of capacity. This process is shown in Table SA.XVII, which reveals that expectations reached their height in the second half of 1931 and first half of 1932.

Information about investment during the Second and Third Five-year Plans, both in general and in the particular case of the machine tool industry, is sparse in comparison with the First Plan period. The draft version of the Second Plan outlined an investment programme for machine tool building of 250 million rubles, or 3.16 per cent of all planned investment in machine building, while the machine tool-tooling and abrasives industry as a whole was to be allocated 440 million rubles, or 5.56 per cent of the total¹. These proportions were higher than those of the previous five years. This plan was revised, however, and in the final published version of the Plan it was stated that 300 million rubles was to be allocated for investment in the specialised machine tool industry, plus a further 30 million rubles in the 'planned' factories, giving a combined share of total planned machine building investment of 4.1 per cent². The reason for this revision is not known, but it is possible that it was decided to devote more attention to the branch after the Seventeenth Party Congress.

Five new factories featured in the Plan, all to be completed by 1937. They were as follows: a grinding machine factory in Khar'kov (3,000 units capacity, and a cost of 19 million rubles); a second grinding machine works, the site of which was later fixed at Voronezh (2,000 units, 17 million rubles); a factory of gear-cutting machines in Gor'kii krai, later changed to Saratov, (1,500 units, 23 million rubles); a factory for building automatics in the North Caucasus, later changed to Kiev (probably because of availability of skilled labour³) (2,000 units, 19 million rubles), and a factory of heavy machine tools in Sverdlovsk (150 units, 20 million rubles).⁴ This last works was to be located near the Uralsmashzavod heavy engineering plant, working on a cooperation basis using reserve capacity of the latter.⁵ It is significant that in an article published before the Seventeenth

10. Proekt vtorogo pyatiletnogo plana razvitiya narodnogo khozyaistva SSSR, 1933-37gg., M, 1934, appendix, Osnovnye ob'ekty kapital'nogo stroitel'stva vo vtorom pyatiletie, pp. 48-49.

11. Planovoe khozyaistvo, 1933, No. 7-8, p. 21.

12. Ibid., p. 22.

13. Proekt vtorogo pyatiletnogo plana, appendix, op cit., p. 43.

14. The second five year plan for the development of the national economy of the USSR, Moscow, n.d., p. 132. (English edition).

Party Congress it was stated that seven new factories would be built, including the five listed and 'S₊ankokonstruktsiya'. It is possible that the unnamed seventh project was the Chelyabinsk heavy machine tool works, one of the biggest new enterprises built during the Second Five-year Plan and one about which little is known. Early in 1934 the machine tool industry's journal reported that this works, which was to have a capacity of 400 large machines of 25 types and sizes to a total value of 53 million rubles, was to be working at full capacity in January 1936 and was to be allocated 56 million rubles investment in 1934.⁶ It cannot be ruled out that the final version of the Plan included this project in the total planned investment for the machine tool industry, thereby accounting for the apparent increase.

The Second Five-year Plan document described the development of machine tool building as "the leading link of the plan of capital work"⁷ and stressed the role of the branch in equipping the entire metal working industry and in strengthening the technical-economic independence of the country. Fulfilment of the plan was poor, however, and to compensate for inadequate development of new capacity more enterprises of other branches of machine building joined the 'planned' machine tool industry. This path had some distinct advantages, of course, in terms of reduced investment demands, easier provision of skilled labour and, above all, time. The only new factory to be built to a reasonable degree of completion was the Kiev im.Gor'kogo automatics factory, on which about 30 million rubles had been spent by mid-1937. This factory started with a capacity of 2,000 units, reduced by the time construction started in August 1934 to 1,500 units of 30 types and sizes⁸, then 680 in early 1935⁹, and finally 500 units by 1937.¹⁰ Only the experimental shop was built at the Saratov gear-cutting machine factory, and the Sverdlovsk heavy machine tool factory project was conserved, a smaller works producing small precision-type machines being developed in its place - the Sverdlovsk factory of small unit-construction machine tools. The two grinding machine factories were not started.¹¹ The fulfilment of the investment plan for the five-year period is not known.

3. See Plan, 1934, No. 1, p. 32 for a critique of this location decision on grounds of the lack of skilled labour.

4. *Ibid.*, p. 31; and *Proekt vtorogo pyatiletnogo plana...*, op cit, appendix, pp. 48-49.

5. Plan, 1934, No. 1, p. 33; *The second five year plan...*, op cit, p. 152.

Examination of the annual investment plans during the Second Five-year Plan, in particular those of 1935 and 1936, and also the later 1939 annual plan, reveals that it was the practice to allocate resources in small amounts to a very large number of projects - in fact almost every single enterprise of the branch was to be a recipient. The usual amount was from 2 to 4 million rubles. This suggests that more could have been achieved with the given resources if a stricter and more purposeful investment policy had been pursued.

Even less is known about the Third Five-year Plan. Early in 1937 Al'perovich proposed the building of at least ten medium sized enterprises and a total investment over the five years of about 500 million rubles.¹² This was challenged by critics at the time on the grounds that such a scale of investment was unnecessary given the existence of large reserves at existing factories. One specialist considered that first priority should go to investment directed towards the completion of existing enterprises and the construction of only three to five new specialised factories for precision machines, grinding machines and automatics.¹³ Al'perovich's original plans were clearly not accepted; in early 1938 it was reported that capital investment for GUSIP as a whole would total 700 million rubles over the five years, i.e. for machine tool building and the production of tooling, abrasives and hard alloys.¹⁴ Of the total 570 million rubles was for the machine tool and tooling branches, and it was intended that 60 per cent of the total allocation should be spent in 1938 and 1939. This new plan was criticised as being too modest; it was reported that 225 million rubles would be required for completing already started machine tool building projects and a further 150 million rubles for uncompleted tooling factories, leaving only 200 million rubles for new construction.¹⁵ In 1938 175 million rubles was allocated for investment in the machine tool and tooling industry,¹⁶ a considerable larger sum than in previous years.

6. *SI*, 1934, No. 4, p. 40.

7. *Proekt vtorogo pyatiletnogo plana...*, op cit., Vol. 1, p. 87. The machine tool industry also occupied first place in the section on investment in machine building.

8. *2a Ind.*, 27.8.34.

9. *Ibid.*, 26.2.35.

10. *Ibid.*, 30.7.37.

11. Aizenshtadt and Chikhachev, op cit., p. 219.

12. *2a Ind.*, 8.5.37; 12.5.37; 12.6.37.

13. *Ibid.*, 12.5.37.

The actual Third Five-year Plan as adopted in 1939 outlined an ambitious programme of new construction for the branch, including a number of factories of medium capacity for building automatics, vertical turning and boring machines, planing, boring and grinding machines, located predominantly to the east of the country.¹ Particular emphasis was placed on the building of capacity for the production of heavy machine tools. In 1938 construction work began on the delayed Sverdlovsk factory and the Kramatorsk heavy machine tool factory, while a shop of heavy machine tool building was built at the Gor'kii milling machine works.² A list of the projects at this time is provided in T.SA.XXVIII. The SNK decree adopted on the occasion of the outbreak of the Second World War listed eleven new factories to be built in 1939-40, in addition to a major programme for the completion of capacity for heavy machine tools.³ But in the following year this programme was cut back and the number of new factories reduced to five because, it is claimed in a recent work, the shortage of metal was growing more acute, and because of the growing danger of war.⁴ The five included a factory of precision machine tools in Penza and one for automatics and turret lathes in Alapaevsk in the Urals.⁵ At the end of 1940 plans were again revised. The joint Party Central Committee and SNK decree on the industry outlined a massive investment programme to a total value of 1,500 million rubles, involving the reconstruction of a number of old factories and the construction of 25 new enterprises, plus an additional 6 factories for allied production. Furthermore, this decree provided for the transfer of a large number of factories of other administrations to the specialised industry.⁶ Early in 1941 Voznesenskii outlined a construction programme for the industry in 1941. This included thirteen new factories, work on some of which had already started. The list of projects reveals the extent of the commitment to developing the industry at this time - heavy machine tool factories in the Urals and Siberia, and factories for boring machines (Siberia), grinding machines (Voronezh), precision machines (Penza), automatics and turret lathes (Urals - Alapaevsk), broaching machines (Kazan), gear-cutting machines (Volga region), large lathes (Ulyanovsk), planing machines (Novosibirsk), automatics and semi-autos (Siberia), lathes (Ryazan), and unit-construction machines in Vladimir.⁷ Strategic considerations

were clearly to the fore, both in the products to be built and in the location of the enterprises, all of which were to be built to the east of Moscow. The War prevented the full realisation of this programme.⁸

The actual volume of investment in the machine tool industry in the 1938-41 years is not known. The only available data refer to the Ukrainian industry and these provide some indication of the pattern of growth over the three pre-War five-year plans. Investment in machine tool building in the Ukrainian republic totalled 11.4 million rubles in the First Five-year Plan, 58.1 in the Second and 118.0 in the Third.⁹

Statistics on the growth of the capital stock of the branch are few and provide only a very general impression. The value of the basic funds of the six main factories of the industry in 1930 on 1st October 1928 was 16.1 million rubles,¹⁰ although the proportion of this actually devoted ^{to machine tool building} in 1928 must have been quite small. By 1931 the total was 28 million rubles,¹¹ and by 1st January 45.7 million rubles, including 27.4 at the old factories.¹² Growth in the Second Five-year Plan was rapid as old factories were reconstructed, new factories entered service and enterprises were transferred from other branches. By 1st January 1935 basic funds of specialised machine tool factories totalled 115 million rubles,¹³ rising to about 300 million rubles in the summer of 1930.¹⁴ Thus basic funds increased by 6.5 times over the five year period. There is no information for later years. The share of the branch in the total basic funds of machine building was smaller than its share of investment, amounting to a mere 1.14 per cent in 1933, rising to 1.86 per cent by the beginning of 1935.¹⁵ For the whole machine tool-tooling

14. *SII*, 1938, No. 2, p. 4.; also *Planovoe khoz'yaistvo*, 1939, no. 3, p. 74.

15. *SII*, 1938, No. 2, p. 4.

16. *Planovoe khoz'yaistvo*, 1938, no. 6, p. 34.

1. *Tretii pyatiletnii plan razvitiya narodnogo khoz'yaistva* Soyuza SSR, M., 1939, p. 122.

2. *Industrializatsiya SSSR, 1938-1941gg.*, op cit, p. 67; *Izvestiya*, 3.10.39.

3. *Direktivy KPSS*..., op cit, Vol. 2, pp. 602-603.

4. *Kas'yanenko, V. I., Zavoevanie*..., op cit, p. 198.

5. *Mashinostroenie*, 8.3.40.

6. *Zhed'*, op cit, p. 16.

7. *Planovoe khoz'yaistvo*, 1941, No. 3, p. 44.

8. Some of these factories were built and entered service during the War and later, including those at Alapaevsk, Voronezh, Ryazan, and a heavy machine tool works at Ulyanovsk.

9. *Puchko, A. A., Razvitie stankostroitel'noi promyshlennosti na Ukraine v dovoennyi period, 1917-1940*, Kiev, 1970, Aftoreferat, p. 10.

and abrasives industry the share of total machine building basic funds amounted to 2.52 per cent in October 1930, rising to 3.47 by the beginning of 1934.¹⁶ Thus, despite its crucial role as the main supplier of industrial equipment the branch was very small in the broader context of the engineering industry - a relationship true, it should be stressed, of all the main machine tool building countries.

The urgent building programme of the Third Five-year Plan when conditions were generally unfavourable would not have been so necessary if the original construction plans of the previous five years period had been realised. Serious difficulties appear to have arisen in 1935. The annual plan provided for a marked concentration of investment resources on just twelve large projects relating to the auto-tractor, rail transport machine building and heavy engineering branches, but not the machine tool industry; these projects accounted for fifty per cent of all investment in machine building in that year.¹⁷ Furthermore, in 1935 the Second Five-year Plan targets were revised in order to accelerate the pace of development of the defence industry.¹⁸ It is clear that the machine tool industry suffered from these measures, although on strategic grounds alone it would seem that it should have been granted higher priority for investment. If this had been realised, import dependence during the Third Plan could have been reduced and the crash programme in the immediate pre-war years to some extent mitigated. In particular, capacity for heavy machine tool building was neglected during the Second Five-year Plan period: this was an especially serious error of planning because shops and factories of heavy machine tool building required relatively large investment outlays and long construction times. The capacity which was created during the Third Five-year Plan period was only completed shortly before the war and production was not properly assimilated by the time the war started.

10. *Plan*, 1934, No. 10, p. 4.

11. *ZaInd.*, 29.10.32.

12. *Plan*, 1934, No. 10, p. 4.

13. *Bol'shevik*, 1935, No. 6, p. 11.

14. *ZaInd.*, 12.5.37.

15. Basic funds of machine building, 1/1933 - *Planovoe Khozyaistvo*, 1934, No. 3, p. 18; 1/35 - *Tyazhelaya promyshlennost' SSSR za 1931-34 gg.*, op cit, p. 12 (both NATP).

16. Basic funds of machine building - *Planovoe khozyaistvo*, 1934, No. 3, p. 18.

17. *Narodno-khozyaistvennyi plan na 1935 god.*, op cit, p. 76.

18. *Istoriya Kommunisticheskoi partii Sovetskogo Soyuza*, Vol. 4, book 2, M., 1971, p. 350.

Table 12.I

Capital Investment in the Machine Tool Industry
(million rubles, prices of corresponding year)

		1928/9	1929/0	Sp.Q	1931	1932	1933	1934	1935	1936	1937	1938
Specialised Machine Tool Industry	P.								(62 ²)	(59 ³)		
	A.	4.1 ¹	10.4 ¹	6.6 ¹	32.8 ¹	38.6 ¹			(50 ²)			
Machine Tool & Tooling Industries	P.				95.0 ⁵		51.0 ⁶	130.8 ⁶	97.3 ⁷	90.0 ⁷		175 ⁴
	A.				*65.2 ⁸	*78.7 ⁸	48.0 ⁸	76.0 ⁸				
Investment as percentage of total in machine building												
Specialised Machine Tool Industry	P.								2.64 ⁹	3.00 ⁹		
	A.	1.65 ⁹	1.95 ⁹	3.17 ⁹	2.16 ¹⁰	1.75 ¹⁰						
Machine Tool and Tooling Industries	P.								4.15 ⁹	4.59 ⁹		
	A.				4.27 ¹⁰	3.57 ¹⁰	2.75 ¹⁰	3.62 ¹⁰				

* excluding 'Stankolit'
(approximate

Source:

1. Kholmyanskii, I., *Spetsializatsiya i kooperirovanie mashinostroeniya v pervoi pyatiletke*, M.-L., 1933, p.28 ; also *ZaInd.*, 28.12.32 (except 1932).
2. Estimated from *Narodno-khozyaistvennyi plan na 1935g.*, p.810, and *Narodnokhozyaistvennyi plan na 1936g.*, Vol.2, pp.296-518.
3. Estimated from *Narkhoz.plana 1936g.*, Vol.2, pp.296-518.
4. *Planovoe khozyaistvo*, 1938, No.6, p.34.
5. *Metall*, 1931, No.1, p.3.
6. *SI*, 1934, No.4, pp.2-3.
7. *Narodnokhozyaistvennyi plan na 1936g.*, 2nd.edn., p.75. Total refers to NKTP mc.build
8. *Sotsialisticheskoe stroitel'stvo*, M., 1936, pp.388-389.
9. Calculated from total investment in machine building (not defined) *ZaInd.*, 28.12.32. This appears to exclude the electrical engineering branch. Percentage for 1931 by this definition 2.71.
10. Calculated from total investment in NKTP machine building - *Tyazhelaya promyshlennost' SSSR za 1931-1934gg.*, M., 1935, p.9.

Chapter 13THE ECONOMIC PERFORMANCE OF THE MACHINE TOOL INDUSTRY

In this chapter an attempt is made to assess the economic performance of the machine tool industry in the period 1929 to 1941, with consideration of the movement of costs, prices, labour productivity and profitability in the specialised branch. Throughout the period in question these economic aspects of the industry's work were not given much prominence in the literature; technical and organisational issues were primary. For this reason it has proved difficult to obtain suitable statistical material on the economic performance of the branch and, while the basic tendencies can be indicated, it is not always possible to provide precise quantitative evidence.¹

Costs

A cost reduction target was included in the annual plans of large-scale industry from 1926-27, and in quarterly plans from 1931.² In machine tool building rationalisation efforts during the second half of the 1920s were directed towards reducing costs, which were then very high compared with both foreign levels and those of machine tool building factories before the War. According to the NKRKI survey of 1929 the average coefficient of cost appreciation for machine tools built by Soviet factories compared with the pre-War level was 2.67, with considerable variation by types and between factories. Machines built by the larger enterprises, e.g. 'Krasnyi Proletarii', tended to be relatively more expensive than those of smaller enterprises because the former had higher overheads stemming from poor production organisation. Thus, the relationship of overheads (shop and factory) to the wages of production workers was 187 per cent for the small 'Samotochka' works, but 279 per cent for 'Krasnyi Proletarii' and 368 per cent 'Dvigatel' Revolyutsii'.³ Cost reduction was, of course, one of the primary concerns of the NKRKI survey and its recommendations.

1. It should be noted, however, that information on the performance of the branch and in particular, of individual enterprises, is available in greater detail in the published literature of the period, than has been the case in the more recent post-War period.

2. Turetskii, Sh. Ya., 'Sebestoimost' i voprosy tsenobrazovaniya, M.-L., 1940, p. 58.

3. 'Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, op cit, pp 167-168.

The movement of costs during the First Five-year Plan years is extremely difficult to determine because of the inadequacy of the cost reduction statistics. Nevertheless, it is clear that costs rose, as the following table indicates, and that cost reduction targets were not fulfilled.

Table 13.1

Annual Reduction of Production Costs in Machine Tool Building¹
(per cent)

	1930 Spl.Q	1931	1932	1933	1934	1935	1936
<u>1. Specialised Machine Tool Industry:</u>							
Planned reduction	-9.0 ²	-19.0	-10.0				
Actual reduction	-1.3 ²	+ 4.4	+4.5	-15.0	-10.2	-3.0	-13.1
<u>11. All Engineering Ind.</u>							
Actual reduction		-2.9	-9.0	-12.3	-12.2	-7.2	-1.2

1. Although not always specified in the sources, cost reductions appear to take account of price changes (this is definitely the case for 1933-1936).
2. Machine tool and tooling industry.

Source:

1. 1930 Spl.Q. - ZaInd., 28.2.31.
1931 - Ek.Zhizn', Aug. 1932, Supplement (annual balances), No. 11.
1932 - Planned - ZaInd., 11.2.32; Actual - ZaInd., 28.4.33.
1933-6 - Sotsialisticheskoe narodnoe khozyaistvo SSSR, 1933-1940 gg., M., 1963, p. 262.
11. 1931, 1932 - Malafeev, A., Istoriya tsenoobrazovaniya v SSSR, 1917-1963 gg., M., 1964, p. 156.
1933-36 - as 1.

This non-fulfilment tells us more about the lack of realism of cost planning during 1931 and 1932 than about the actual performance of the branch. The problem of the period was the introduction of new models of modern design, which raised costs for the factory and rendered cost reduction statistics unsatisfactory because they generally only took account of cost changes for comparable products. For 1932, for example, comparable products taken as a basis for calculating cost changes accounted for only 34 per cent of the gross output of the branch.¹ During the First Five-year Plan years the switch to new modern models involved considerable outlays on fixtures and tools and other costs of assimilation; the role of engineering and technical workers rose sharply, costs of training and providing facilities for a greatly expanded labour force had to be met, and the

^{1. ZaInd., 28.4.33. This point is also stressed by Kuperman, Vestnik metallopromyshlennosti, 1935, No. 9, p. 113.}

introduction of new machinery raised depreciation charges. These factors combined to produce a substantial increase in overheads, e.g. in 1932 alone they rose by 36 per cent.¹ The assimilation of new models in some cases led to very large cost increases; for the im.Sverdlova factory in 1931, when the R-80 boring machine was being mastered, costs rose by 46 per cent during the year, against a plan target of a 20.5 per cent cost reduction!²

The initial cost of new models introduced in the years 1931 to 1933 tended to be extremely high, and there was a very substantial difference between the cost of these new models and the price of existing older models of the same type. Thus, in 1932 the DIP-200 lathe had an average cost of 15,000 rubles, whereas the price of lathes of this size had been provisionally fixed at 4,000 rubles in the summer of 1931,³ and the price of the DIP-200 lathe itself had been provisionally set at 9,100 rubles in mid-1932.⁴ The new boring machine of the im.Sverdlova factory had a cost in 1931 of 73,000 rubles (a provisional price of only 9,000 rubles was fixed for machines of this type⁵), and the factory was unofficially asking a price of 70,000 rubles for its new planing machine, although a slightly smaller, older, model built by the Odessa im.Lenina factory was priced at only 4,000 rubles.⁶ However, as the scale of production of these new models rose and initial production problems overcame, costs fell rapidly. In the first half of 1933 costs were cut by almost 24 per cent compared with the same period in the previous year.⁷ As Table SA.XXI shows, the cost of the DIP-200 lathe was more than halved by the end of 1934, when it reached 7,206 rubles, while the cost of the Gor'kii milling machine factory's '682' universal machine fell from 40,207 rubles in 1932 to 13,500 rubles in 1934.⁸ An indication of the extent of cost reductions for new models introduced in 1931 and 1932 is provided by the following table; the new models of 1932 were greater in number and more significant for the development of the branch than those of 1931.

1. ZaInd., 28.4.33.

2. Leningradskaya tyazhelaya promyshlennost', 1931-1934, L.-M., 1934, p.263. In the following year, however, costs fell by 17.4 per cent, against a target of 24.8 per cent - *ibid.*

3. ZaInd., 23.7.31.

4. *ibid.*, 3.8.32.

5. *ibid.*, 23.7.31.

6. *ibid.*, 15.1.33.

7. *ibid.*, 21.9.33.

8. See p.581.

Table 13.II

The Changing Cost of Comparable Products - Metal cutting and forming
Machine Tools, 1932 - 1936¹

	1932	1933	1934	1935	1936
<u>1. Cost Index, 1932 = 100</u>					
All comparable products	100	75.6	65.8	62.1	46.4
including:					
First produced in 1931	100	94.1	82.0	76.2	53.6
First produced in 1932	100	66.9	50.8	43.6	30.6
<u>II. Annual cost reductions(%)</u>					
All comparable products	-	-24.4	-12.9	-5.6	-25.3
including:					
First produced in 1931	-	-5.9	-12.9	-7.0	-29.7
First produced in 1932	-	-33.1	-24.0	-14.2	-29.9

1. Without account of price changes

Source: Calculated from Turetskii, *op cit*, p.98.

The large cost reduction shown above for 1936 presumably reflect the impact of the Stakhanovite movement and the revision of output norms which took place in 1936.

The new enterprises coming into operation at the end of the First Five-year Plan faced a particularly unfavourable cost situation, because the high overheads of the assimilation period had to be distributed over a small output. As a result overheads represented a very high proportion of total costs, as can be seen from the case of the im.Ordzhonikidze factory, the economic performance of which was very poor in the first three years. The following shows the changing structure of the factory production cost of the basic product of the enterprise, the '136' turret lathe. In this case overheads represented 63 per cent of total cost in 1933, falling to a planned 53 per cent in 1935. The case of the Gor'kii factory was similar: overheads represented about 60 per cent of the total cost of the '682' milling machine in 1934.¹ The older, more experienced factories achieved better results, e.g. the Tula factory, one of the most successful in the mid-1930s in reducing production costs, in 1935 achieved the following cost

¹ ZaInd., 29.9.35.

structure for its basic product, the '681G' ('Dzerzhinets') milling machine: materials (including spoilage) - 32.5 per cent; wages of production workers - 17.6 per cent; and overheads - 49.8 per cent.¹ In late 1935, Sushkov, the

The Cost Structure of the '136' Turret Lathe , 1933 - 1935 Table 13.III

Item of cost	1933		1934		1935 Plan (4thQ)	
	Cost(r.)	% total	Cost(r.)	% total	Cost(r.)	% total
Materials	4,855	28.2	4,564	29.5	4,692	36.7
Wages of Prod'n.Wrks.	1,496	8.7	1,646	10.6	1,364	10.7
Shop Overheads	5,287	30.8	6,036 ¹	39.0	4,277	33.4
Factory Overheads	5,551	32.3	3,228 ¹	20.9	2,455	19.2
Total cost	17,189	100.0	15,474	100.0	12,788	100.0

1.Changing proportions mainly result of the transfer of many engineering and technical personnel from the factory administration to the shops.

Source: 1933 and 1934 - Vestnik metallopromyshlennosti, 1935, No.9, p.118.
1935 4th quarter plan - ZaInd., 11.11.35.

director of the im.Ordzhonikidze factory, cited the German specialist , Schlesinger who for the German machine tool industry had outlined an optimal cost structure for a machine tool of average weight of: materials - 41.2 per cent; wages - 18.3 per cent; and overheads - 40.5 per cent. Sushkov considered this a desirable and feasible target for the Soviet industry, and demonstrated that it could be achieved at his factory on the condition that output norms were overfulfilled by at least one hundred percent!²

In 1933 large cost reductions were achieved as the new models were assimilated , but from the beginning of the Second Five-year Plan, as the branch entered the third phase of its development and the expansion of the tipazh became a central concern, the problem of reducing costs became more difficult and the rate of annual reduction fell in 1934 and to a still greater degree during 1935. A substantial cost item at this time was spoilage (brak). This waste production resulting from poor materials, inexperienced workers , and design and technical errors accounted for a rising proportion of total output from 1931 to 1934, when it attained no less than 8.8 per cent of the cost of gross output

1.ZaInd., 29.2.36.

2.ibid., 11.11.35.

of GUSIP factories.

Spoilage as a Proportion of Total Annual Cost of Gross Output Table 13.IV
(per cent)

	1931	1932	1933	1934	1935	1936	1937
Specialised Machine Tool Industry	3.6	6.4	7.1				
All GUSIP (i.e. inc. tooling industry)				8.8	7.3 ¹	6.4	6.6

1. First six months only.

Source: 1931 - Sokolov, A., *Sovetskoe stankostroenie*, M., 1932, p. 21.

1932, 33 - *StI*, 1934, No. 4, p. 2.

1934, 35 - *Plan. Khoz.*, 1936, No. 2, p. 37.

1936, 37 - *ibid.*, 1938, No. 5, p. 25.

It would be a mistake, however, to regard this rising share of accounted spoilage solely as an indication of a deterioration of quality of work; it also reflected rising quality standards and an improvement in quality inspection. From about 1935 the proportion of spoilage showed a downward trend, but nevertheless remained at a high level: in 1937 the total value of spoilage in GUSIP as a whole amounted to no less than 35 million rubles.¹ The trend during the Third Plan is not known, but in 1939 spoilage accounted for only 2.1 per cent of the total cost of production at the 'Krasnyi Proletarii' factory.²

In 1935 the attention of the NKTP leadership and also that of GUSIP turned more seriously than in previous years to the problem of cost reduction, and a drive for profitable operation began. In the machine tool branch this campaign was directed towards securing price reductions in order to bring Soviet prices more into line with foreign equivalents, while at the same time attempting to free the branch from subsidies. With the development of the Stakhanovite movement from the autumn of 1935 real successes were achieved, and the rate of cost reduction rose sharply in 1936, giving the Glavk a substantial above-plan profit for the year.³ Direct evidence on the movement of costs during the Third Five-year Plan period is lacking, but it is reasonable to assume that the rate of

1. *Plan. Khoz.*, 1938, No. 5, p. 25.

2. *Mashinoströenie*, 1.2.40.

3. *ZaInd.*, 10.3.37.

reduction slowed considerably, and may even have been reversed, as the branch strived to build a large number of complex special and specialised models. At the leading 'Krasnyi Proletarii' factory costs were cut by 4.6 per cent in 1938 and 7.8 per cent in 1939¹; these reductions were probably obtained through the development of flow assembly of the main large-serial models. Indirect evidence that problems of reducing costs were greater during the 1938 to 1941 period is provided by the fact that prices of machine tools built by both the Glavk and the 'planned' factories during this period were not reduced, in marked contrast to the previous three-four years when reductions had been frequent.

Prices

Given the vital role of the machine tool industry in supplying production equipment to the rest of the engineering industry, the question of the price of domestically produced machine tools was of particular importance, especially during the Second Five-year Plan, when imports formed a smaller proportion of total installations. Information about price fixing policy before and during the First Five-year Plan is sparse. The first complete list of all Soviet built machine tools and their prices was published in 1930 as a guide for those ordering equipment in the following year.² It is known that general machinery prices (probably including machine tools) were reduced by up to 4.7 per cent according to a VSNKh order of 14th February 1929³, and that machine tool prices were cut on average by 4 per cent on 1st October 1929. In September 1930 a turnover tax of 4.2 per cent was imposed on ^{the} machine tools and tooling industry, which may have led to corresponding price increases for machine tools.⁴ Price lists were published in 1931 and 1932 in connection with the placing of orders, but as the latter explicitly specified, these were 'orientational' prices only. In both lists the prices of a number of new models recently introduced or about to be assimilated were clearly unrealistic.⁵ Price discipline was not always observed by factories of the branch at this time: one critic early in 1933 noted that some factories were taking advantage of the 'high conjuncture' and charging excessive prices on new and special machines.⁶

1. Mashinostroenie, 2.10.39; 1.2.40.

2. Za. Ind., 31.10.30.

3. Torg. Prom. Gaz., 16.2.29.

With the introduction of new, modern models and the modernisation of older machines prices rose sharply, partly because factories tended to pass on the high initial costs to customers. Nevertheless, some prices were below cost at this time, e.g. in 1934 the '114' semi-automatic had a list price of 25,000 rubles, although its cost in that year averaged 25,021 rubles.⁷ This problem continued into 1936 - in February the director of 'Krasnyi Proletarii' claimed that prices of most machines built by his factory could not be further reduced because they were below cost.⁸ But, in general, as the new models were put into regular batch production their cost fell quickly, giving the possibility of quite substantial price reductions.

A procedure for approving machinery prices was laid down by an SNK decree of 5th August 1933, which established that STO was to approve prices for a wide range of products, including machine tools, made on a mass or batch basis. The prices of other products were to be fixed by agreement between the producer and the customer.⁹ In the case of machine tools this latter provision clearly applied in the case of special machines and, in practice appears also to have applied to new machines in the initial period of their production before an STO approved price had been fixed. Approved prices were listed in price handbooks which appeared annually from 1935 (covering all machines built in the USSR). Prices of new machines not yet assimilated into batch production, and of special machine tools, were listed in the price handbooks as 'contract' prices, providing an approximate indication of prices set by mutual agreement of buyer and seller. The system of contract prices was open to abuse as factories were sometimes able to offset losses by fixing extremely high prices for 'one-off' special machines, e.g. in April 1935 the director of the im.Sverdlova factory was reprimanded in an NKTP Order for gross violation of price discipline - a special machine supplied

4. Izvestiya, 13.9.30. This rate of 4.2 per cent was almost the lowest of rates fixed for a range of industries by an SNK decree.

5. ZaInd., 23.7.31; 3.8.32. The 'Komsomolets' factory's combined machine tool, for example, was priced in the 1931 list at a mere 3,000 rubles; in the following year at 20,000 rubles.

6. ZaInd., 15.1.33.

7. See Table SA.XXIX.

8. ZaInd., 24.2.36.

9. SZ, 52-304 (1933)

to Dvigatel'stoi had been priced (with the agreement of the buyer and GUSIP) at 510,000 rubles, subsequently cut by the Order to 120,000 rubles.¹

As new models entered regular batch production costs fell and measures were taken to reduce the machine tool price level. An STO decree of 16th March 1935 outlined price reductions for equipment for many branches of industry, including machine tools. According to this measure GUSIP was to introduce price cuts giving a total saving of 11.6 million rubles , and GVMU (Glavnoe voenno-mobilizatsionnoe upravlenie) cuts providing a saving of 4.9 million rubles (presumably this applied to the machine tools produced by the defence industry).² The overall percentage reduction was not stated, but from the known planned output of the Glavk in 1935 it must have been about 10 per cent. In February 1935 a campaign began for the further reduction of machine tool prices, initiated by the director of the Tula Arms factory ,Vannikov, who declared that the prices of machine tools built by his enterprise would be reduced by 20 per cent in 1936. Al'perovich soon replied, stating that the Glavk had reviewed costs and was to reduce prices by 27.8 per cent. But in March the government acted to reform prices in general in order to strengthen khozraschet and eliminate subsidies. According to this measure prices in some branches were increased and in others had to be reviewed to take account of consequent increases in material and fuel costs. To offset these increases the rate of turnover tax applied in heavy industry was reduced to 0.5 - 2.0 per cent compared with the previous rates of up to 5 per cent.³ Furthermore, some of the costs of assimilating new technology and training cadres were transferred to the state budget.⁴ This measure led to a review of the previous price reduction intentions of the machine tool industry; in 1936 new prices approved by STO provided for an average reduction of only 6 per cent.⁵

The next machine tool price review occurred in January 1937 when according to a SNK decree the prices of a number of machines were further reduced, e.g. the price of the 'DIP-300' lathe was cut by 2,680 rubles to 15,000 rubles, but this review appears to have been restricted to a limited range of models.⁶ During

1. ZaInd., 29.4.35. Building special machines could also be 'profitable', not simply through setting artificially high prices, but by fixing exaggerated planned cost estimates which entered enterprise annual plans for cost reduction; cont. next page..

the Third Five-year Plan, following the break up of NKTP and the subsequent further fragmentation of administrations, authority for approving price changes appears to have been decentralised to the Commissariats. Between 1937 and 1941 there were no more across-the-board price reviews for machine tools, and with few exceptions, prices remained stable over the four year period⁷. At this time machine tool prices were approved by a very wide range of organisations, including NK Mashinostroenie, NK Tyazh Mash, NK Zem., NK Mest. Prom. of the republics, and GULAG, and in a few cases this led to the fixing of different prices for the same model built by enterprises of different organisations.⁸ No evidence on the extent to which price discipline was observed at this time has been found, but the reduction of central control may well have led to some deterioration. It may be significant that in 1940 the prices of a number of new basic models built by the specialised industry were approved by Ekonomsotvet, indicating a reassertion of high-level, central authority.⁹

The movement of prices and costs of a number of the most important models built in the pre-War years is shown in Table SA.XXIX.

During the Second Five-year Plan concern was expressed on a number of occasions, notably by M. Kaganovich, over the very great difference between the prices of Soviet and foreign machine tools. Estimates of the magnitude of this difference varied. One observer in March 1935 considered that Soviet prices were three to four times higher; Kaganovich in August of the same year believed that Soviet machines cost six to seven times more than foreign equivalents.¹⁰ Reducing this differential was one of the aims of the price and cost reduction campaigns of 1935 and 1936. But not only was the absolute level

the difference between these cost estimates and real costs providing additional profits and facilitating the fulfilment of the cost reduction target - the

1. Sverdlova factory was also found guilty of this deception - ZaInd., 6.5.35.

2. Nashe stroitel'stvo, 1935, No. 9, p. 36.

3. The new rate for the machine tool industry is not known.

4. Malafeev, *op cit*, p. 185.

5. ZaInd., 18.4.36.

6. *Ibid.*, 5.2.37; Plan, 1937, No. 7, p. 52.

7. The 1940-41 price handbook reveals that the prices of many models built by enterprises of the defence industry were slightly reduced in August 1938.

8. Metallorazhishchie stanki. Preiskurant, 1940-41 gg., M.-L., 1941.

9. *Ibid.* Ekonomsotvet under SNK was the supreme economic body of the time.

10. ZaInd., 29.3.35.

11. *Ibid.* 1.8.35

of prices much higher, but the price differentials between simple and complex machines were also greater than for foreign machines. Thus, in October 1935 it was estimated that the cost of the DIP-200 (x750) lathe was three times higher than the price of the equivalent foreign model, and that of the '136' turret lathe 3.6 times higher, but the price of the '114' semi-auto was eight times higher than the price of the equivalent foreign model, and that of the '116' semi-auto 15.8 times higher. In the USSR the '113' automatic of the im.Ordzhonikidze factory was 10.5 times as expensive as the TN-20 lathe; abroad the difference was only four times. Thus the prices of Soviet machines produced on a large-serial basis were three-four times higher than for similar foreign models, but very much greater for specialised machines built on an individual or small batch basis. There was concern that the pattern of price differentials would discourage enterprises from using more complex, specialised equipment, inducing a bias towards simpler, general purpose types.¹ Between 1935 and 1937 the differential in price between general purpose and specialised machines was in fact narrowed because in many cases the cost reductions for the latter tended to be greater than for the former.²

The overall movement of machine tool prices during the period can be approximately indicated. Between 1928 and 1930-31 prices fell by a small amount each year; from 1932 prices began to rise, increasing quite sharply in 1933 and 1934; in 1935 and 1936 prices were reduced, with further more limited reductions in 1937; but from 1938 to 1941 prices of comparable models remained stable. There have been two attempts by American economists to construct indices of Soviet machine tool prices in the pre-War years.³ Both attempt to represent by an index number the average price of a machine tool produced in a given year, weighting the

1. *Vestnik metallopromyshlennosti*, 1935, No. 10, pp. 4-5.

2. For example, the ratio between the prices of the '136' turret lathe, the '116' semi-auto, and the '123' four-spindle automatic (all built by the im. Ordzhonikidze factory) changed as follows: 1935 - 1:2.6:3.8; 1936 - 1:2.0:3.3; 1937 - 1:1.4:3.2 (calculated from prices listed in handbooks of corresponding year 1928-51, RAND).

3. Turgeon, L., *Prices of metalworking equipment in the Soviet Union, 1928-51*, RAND Research Memorandum, RM-1112, 1953; Moorsteen, R., *Prices and production of machinery in the Soviet Union, 1928-58*, Harvard, 1962.

series by the structure of output in certain base years. The results obtained are shown in the following table:

Table 13.V

Price Indices for Soviet Metal cutting and forming Machine Tools
(1937 = 100)

Index	1927/8	1928/9	1929/0	1931	1932	1933	1934	1935	1936	1937-41
Turgeon ¹	55.8	55.8	53.6	35.7	44.2	80.0	107.2	100.2	101.1	100.0
Moersteen ²	70.2	70.2	67.3	46.7	51.0	95.2	128.0	119.4	101.7	100.0

1. Turgeon, op cit, p.50 (1937 output structure weights)

2. Moersteen, op cit, p.390. (1937 output structure weights)

The Moersteen index is probably the more accurate of the two, but both suffer from a number of serious weaknesses. The price data employed is far from complete, being gathered from scattered journal sources rather than the price handbooks cited in the present work. Information on prices is particularly weak during the 1927/8 to 1933 period because the 'orientational' prices are employed, even though they clearly understate the actual price level in so far as new machines were frequently listed at clearly understated pre-production estimated prices. Furthermore, the number of prices taken for some years was very small in both cases. No account is taken of qualitative changes and special machine tools, which accounted for an increasing share of total output in the course of the period are completely omitted. Finally, the output data employed is of a rather sketchy nature, that referring to the structure of output being especially weak. Despite these problems, the general trend indicated by the indices probably provides a reasonably accurate impression of the actual movement of prices, with the proviso that in both cases the fall in prices in 1931 and 1932 compared with 1929-30 is probably overstated, while Turgeon's index appears to understate the extent of the fall in prices between 1934 and 1937.

The Profitability of the Industry

During the First Five-year Plan and the beginning of the Second the specialised machine tool industry was almost certainly a subsidised branch. This

can be deduced from the fact that a serious campaign for profitable operation began only in 1935. It is known that Stankoob'edinenie made a loss of 1.78 million rubles in 1931, when its marketed output amounted to 36.42 million rubles.¹ In 1935 a campaign started in heavy industry for profitable operation and an end to subsidies. A pioneering role in this campaign was played by the im.Ordzhonikidze machine tool factory which, in 1935, succeeded in obtaining a one million ruble profit despite a plan target of a two million ruble subsidy.² In 1935 the new Gor'kii works also became profitable,³ but other enterprises of the branch, notably the smaller factories and those newly assimilated (including 'Samotochka', im.Ts.K.Mashinostroeniya, 'Komsomolets', im.Lenina, Khar'kov and 'Stankokonstruktsiya') still required subsidies.⁴ For GUSIP as a whole, 18 enterprises made profits totalling 24 million rubles, but 20 made losses to a total of 36 million rubles, giving a net loss of 12 million rubles.⁵ In 1936 it was intended that only five machine tool factories would receive subsidies from the internal resources of the Glavk, namely 'Stankokonstruktsiya', Khar'kov, the factory of small unit-construction machines in Sverdlovsk, and two enterprises recently transferred to the Glavk, im.Kirova in Tbilisi and im.Sedina in Krasnodar.⁶ The campaign for profitable operation was successful; despite price reductions, the Glavk as a whole ended the year with a significant above-plan profit.⁷ The branch appears to have remained profitable for the rest of the period.⁸

Labour Productivity

The vital importance of raising labour productivity in the branch was acknowledged from its earliest days. It is, however, very difficult to provide a satisfactory measure of changing labour productivity in the machine tool industry during the pre-War years; data for value of output are incomplete and

1. Ek.Zhizn', Aug.1932, supplement, 'annual balances', No.11.

2. ZaInd., 2.1.36.

3. Istoriya industrializatsii nizhegorodskogo-gor'kovskogo kraya, 1926-1941gg., Gor'kii, 1968, p.334.

4. ZaInd., 18.4.36.

5. ibid.

6. ibid.

7. ibid., 10.3.37.

8. In 1937 GUSIP had a profit rate of 9-10 per cent (Plan.Khoz., 1938, No.10, p.57) and profitability in 1938 and 1939 can be inferred from the fact that NKTyazhMash (of which GUSIP was a major component) made profits of 4.2 and 103.5 million rubles respectively - Mashinostroenie, 12.2.40.

strongly influenced by the change in unit value of machines built, while an index of the number of physical units built per worker cannot take account of qualitative changes. The limited evidence on changing labour productivity in the specialised machine tool industry is presented in the following table:

Table 13.VI

Labour Productivity in the Specialised Machine Tool Industry*

	1928/9	1929/0	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
1. Output/worker ¹ per year (r.)	1680	1865	1555	2460	3580	4165	4865	5800	6515			
Index												
1932 = 100	68	76	63	100	146	169	198	236	265			
1938 = 100										100		150
Previous year = 100	-	111	83	158	146	116	117	119	112			
11. Number of mc.ts (units) per wrk/yr	0.61	0.65	0.75	0.55	0.59	0.52	0.55	0.61	0.64	0.90	1.00	0.97

* Approximate

1. Marketed output in 1926/27 prices; workers (rabochie) only

Source:

1. 1928/29 - 1934 calculated from marketed output data (Prob. Ek., 1935, No. 4, pp. 194 & 20) and number of workers (Table 11.I) Note, number of workers 1928/29 taken as 4,170 and 1929/30 estimated as 7,500.

1935 and 1936 estimated, on basis of interpolation between 1934 and 1937 for marketed output

1937 - calculated from marketed output of 159.4 m.r. obtained from 486 per cent increase over 1932 - Aizenshtadt & Chikhachev, op cit, p. 214.

1938-1940 - Index - Klimenko, K.I., Puti povysheniya proizvoditel'nosti truda v mashinostroenii SSSR, M., 1950, p. 12 (This probably refers to gross output)

11. Calculated from data of Table SA.I and Table 11.I (No. of workers 1928/29-29/30 as 1. above). Note - Plan. Khoz., 1939, No. 9, p. 52 also gives 0.64 units per worker in 1937.

The influence of the transition to new modern types from 1932 is clearly visible; the value per unit machine built rose very rapidly from 1931 to 1934, but the number of machines built per worker fell as they became more complex; the fall in 1932 also reflecting the influx of new workers into the branch. From 1935 the units per worker indicator began to recover, exceeding the 1931 high point again in 1938. Labour productivity continued to rise steadily during the Third Five-year Plan years, when it is estimated to have accounted for over 80 per cent

of the growth of production¹. Taking the period 1932 to 1940, labour productivity in value terms must have increased over four times, and over six times between the start of the First Five-year Plan and the War.

Information on the growth of labour productivity at individual enterprises is only available for three leading factories - 'Krasnyi Proletarii', the Gor'kii milling machine factory and the im. Ordzhonikidze works in Moscow.² From an initial very low level of output per worker, the two new enterprises rapidly achieved levels superior to that of the older factory. The impact of the transition to new models was particularly acute in 1933 at the 'Krasnyi Proletarii' factory; output per worker actually fell. The other, small enterprises of the branch, producing less complex machines, presumably had a much lower level of labour productivity, because the branch average indicated above was much lower than that of the three leading factories.

Many of the means of raising labour productivity have been discussed elsewhere. These included increasing the seriality of production, improving work organisation, improving production technology, standardisation, the development of sub-contracting, raising labour skills, and socialist emulation campaigns. The Stakhanovite movement undoubtedly had a positive influence on productivity in the branch and was associated with at least two major revisions of output norms. In February 1936 the Glavk held an all-Union conference to discuss new technical norms founded on intensified cutting regimes and these technical norms provided a basis both for reviewing project capacities of enterprises and increasing output norms for a very large number of operations.³ Output norms were raised on average by forty per cent in May 1936 for GUSIP as a whole and by the end of the year it was reported that they were being fulfilled or overfulfilled by 84 per cent of workers.⁴ By means of raising output norms some of the gains achieved by individual Stakhanovite workers were diffused throughout the branch as a whole. A second branch-wide revision of output norms took place in April 1937; by June 1938 the average rate of fulfilment for the branch was

1. Klimenko, *op cit*, p. 12.

2. See Table SA.XXX. Note, not directly comparable with industry data (p. 424) because gross output is employed.

3. *Za Ind.*, 14.2.36.

4. *Plan. Khoz.*, 1937, No. 8, pp. 37-38.

almost 170 per cent, only 10.5 per cent of workers failing to meet them.¹ During the Third Five-year Plan considerable attention was devoted to improving production organisation and methods, while emulation developed to embrace multiple machine manning. At some enterprises, e.g. 'Krasnyi Proletarii', these measures led to a reduction in the number of workers employed, and quite substantial productivity increases.

It is not possible to make any meaningful comparisons of labour productivity in the Soviet machine tool industry and the industries of other countries during the 1930s on the basis of the available information. Apart from the usual problem of determining an appropriate exchange rate, there is the formidable difficulty of accounting for differences in the structure of the Soviet and foreign industries, the latter generally showing a higher level of development of specialised process and parts production. Furthermore, we have only considered the specialised machine tool industry, which accounted for less than half total output during most of the period, information about productivity of the remainder being unobtainable. Soviet economists did not attempt to make any but the most elementary comparisons at the time. Two comparisons have been traced, both giving the same result although referring to different periods. The first compared the Soviet and American industries in 1927/28 and concluded that output per wage earner in the former was one third of that of the latter; the second compared the Soviet industry in 1935 and the American in 1929 and again concluded that labour productivity in the Soviet industry was one third of the American level.² These rough estimates indicate the magnitude of the task of 'catching up' now facing the Soviet machine tool industry of the thirties.

1. ZaInd., 17.4.37; Plan. Khoz., 1938, No. 10, p. 78.

2. 1927/28 - Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, op cit, p. 167.
1935/29 - Khromov, P. A., Proizvoditel'nost' truda v promyshlennosti SSSR, M., 1940, p. 204.

Conclusion

The efficiency and productivity of the machine tool industry as one of the primary suppliers of basic production equipment to the engineering industry and other branches is an important factor determining the cost of production of industry as a whole. The Soviet machine tool industry during the period under investigation was faced with a formidable problem of reducing the considerable cost and price differential existing between its products and those produced abroad, while at the same time making the transition from small-scale production of simple, backward models to large-scale production of more complex, modern machines. During the transition period, in particular the years 1931 to 1934, costs and prices showed a tendency to rise as new models were assimilated and at this time the branch was subsidised, although the full extent of this subsidisation is not known. After this relatively brief transition period costs and prices were somewhat reduced and labour productivity rose quite strongly for the remainder of the period. By the mid-1930s the branch was operating without subsidies. This picture is incomplete, however, because only the specialised component of the industry has been considered. The defence industry machine tool building enterprises do appear to have been relatively efficient producers, at times setting a lead for the industry as a whole in reducing costs and prices, but the situation in the rest of the industry was presumably less satisfactory. By the end of the decade there were many small-scale producers making simple machines by methods which must have been extremely primitive compared with those of the main specialised factories; by 1940 there must have been a substantial gulf between best and worse practice with very substantial variations in costs and productivity. The growth of labour productivity achieved in the specialised industry from the mid-1930s suggests that the relative level of productivity between the Soviet industry and foreign equivalents may well have been raised by the War, but this may not have been the case for the industry as a whole, because of the necessity of maintaining a substantial number of secondary producers in conditions of acute scarcity of machine tools of all types.

Chapter 14CONCLUSION

The machine tool industry is a relatively small branch of production in any economy. In the Soviet Union in the early 1930s it accounted for a mere two per cent of the total output of the machine building and metal-working industry. Yet its economic and strategic importance is far greater than this simple quantitative measure suggests. One of the most serious problems for Soviet machine tool building was that of establishing its priority as one of the most important branches of the engineering industry and of industry as whole. There is no doubt that in the 1920s its significance was not sufficiently appreciated. Despite the clear call of the Fourteenth Party Congress for the development of an independent machine building capacity the industrial and economic leadership of the time did not pay much attention to machines for building machines. Imports supplied almost all requirements and machine tool building was not considered sufficiently consequential to merit the creation of an effective administrative centre. The decision in early 1929 to form a separate trust marked a significant step forward. There is no doubt that the 'turn' at this time owed much to the activity of NK RKI and M. Kaganovich in exposing the serious weaknesses of machine tool building and drawing attention to the necessity of granting it higher priority.

In 1930 the plans for the machine tool industry were revised substantially and on paper at least it appeared that the status of the industry had been acknowledged; but in fact in that year the branch took second place to other sections of the engineering industry in resource allocation, seriously restricting its ability to fulfil its investment programme during the five-year period. The ease with which machine tools could then be imported, coupled with the prevalence of the view that machine tool building was too complex a matter to be quickly undertaken, seems to have promoted an attitude that the branch could wait until circumstances were more favourable. This outlook was challenged by Al'perovich

and other industrial leaders who appreciated the significance of quickly laying the foundations of a strong domestic machine tool industry. The advocacy of NK RKI , in particular M.Kaganovich in person, was again important ; and there does appear to have been a definite improvement in the status of the branch and its ability to obtain resources when Ordzhonikidze took over the leadership of VSNKh , and Kaganovich was made responsible for the engineering industry.

During the First Five-year Plan period new branches of engineering were created , notably vehicle and tractor building , which were much larger in size than machine tool building and generally had much greater political-economic weight than the machine tool branch. Not only did they tend to take priority within the engineering sector to the detriment of other branches, they also increasingly began to impose demands on the machine tool industry and seriously influence its path of development. By the beginning of the Second Five-year Plan the status of the machine tool industry had undoubtedly risen , but again, despite plans which acknowledged its leading role and provided for substantial investment allocations, resources were not forthcoming on the scale foreseen. It is clear that the demands of military production played a large role in diverting resources from civilian branches at this time , but it is curious that, given its strategic importance, the machine tool industry should have suffered to such an extent. The construction plans of the branch were very greatly under-fulfilled ; a short-term view seems to have prevailed with capacity being expanded at existing enterprises of the engineering industry. This was in many respects a sensible policy, but it was not in itself adequate to meeting all the needs of the economy; in particular it led to the neglect of two sections of the industry of vital military importance, namely the building of heavy and precision machine tools. During the Third Five-year Plan years in far more difficult economic conditions the Party and government was forced to take urgent measures to remedy these weaknesses, above all by rapidly building capacity for heavy machine tool production. Furthermore, at this time measures were taken to correct the regional imbalance of the machine tool industry . Most of the new projects were located in the east of the country, a number in the Urals and Siberia.

This leads one to conclude that if higher priority had in fact been granted to the machine tool branch in the Second Five-year Plan period, problems of developing the engineering and defence industries in the immediate pre-War period would have been less acute. In the event the ambitious plans of September 1939 and the massive programme outlined in December 1940 were only partially realised by the outbreak of war.

The leadership of the machine tool industry clearly found it difficult to obtain recognition of the priority of the branch. Al'perovich and the other leaders of the industry did not carry the same political weight as did the leaders of the auto-tractor industry and the directors of its large factories. The building of machine tools lacked the mass public appeal which attached to the giant tractor factories and other major projects of the period. At the end of 1935 the industry lost its powerful advocate in NKTP, M.Kaganovich, who became the head of the aviation industry, and this fact may account for some of the industry's problems towards the end of the Second Five-year Plan. Another difficulty facing the specialised machine tool industry was that it had to compete for resources with the machine tool building shops of the favoured defence industry. On the other hand, the splitting of NKTP at the end of 1936 to form a separate defence industry commissariat may have had negative consequences in so far as it must have made interchange of experience between the machine tool builders of both sections much more difficult. Thus, while in theory the priority of the machine tool industry was generally recognised and this found its expression in the resolutions of Party congresses and conferences, and in planning documents, in practice the industry by its nature found itself often at a distinct disadvantage.

In 1933 Al'perovich declared that there had been no errors of principle in the development of the machine tool industry: this was surely correct. The mistakes and problems that occurred were in the realisation of the strategy of development, rather than in the strategy itself. Mistakes there certainly were - the policies of Phase Two were carried to extremes, the labour skills required were underestimated, the implications of technical progress were not perceived correctly

In the early period, there was an excessively distrustful attitude towards foreign technical assistance, and there was perhaps an over-abrupt cut back in machine tool imports. Some of these problems stemmed from the fact that in the first stages of industrialisation there was a rather abstract understanding of the differences between the capitalist and socialist economies. It took a number of years to arrive at a more concrete appreciation of the specificities of each system and their implications for industrial organisation in the Soviet economy. The development of the machine tool industry, and industry as a whole, at this time was not just a question of building new factories and products, it was a complex learning process undertaken under conditions of intense pressure. This learning process was in part affected by the manifest failure of the capitalist economic system at the time of the most tense industrialisation effort; a failure which could not but reinforce an already present tendency to reject, a priori, all things capitalist.

During the First Five-year Plan period this radicalism reached its highest point. In many spheres, notably in relation to the possibilities of production specialisation, the scope for mass production and the technology appropriate for Soviet conditions, forms stemming from a schematic understanding of the advantages of the socialist planned economy were counterposed to the reality of capitalist practice without regard for the achieved level of development of the Soviet economy at the time. This tendency was quite short-lived, enjoying its apogee during 1931 and the first half of 1932, and while it did not have any real practical consequences for the machine tool industry it must have made its general conditions of work more difficult. The leadership of the industry at all times had a much more sober assessment of the path to be followed and the possibilities of each stage, but it constantly had to face criticism of its actions and policies both from observers on the sidelines and from within its own ranks. These criticisms, frequently of a destructive and sceptical nature, and sometimes ill-informed, created a climate of suspicion and distrust which served to erode the authority of the industry's leadership. Such criticism stemmed not just from radical theorists, but also the industrial press which

played a distinctly ambivalent role during the first two five-year plan periods (the character of the press changed somewhat in the Third Five-year Plan , as can be seen by comparing Mashinostroenie of , say 1938-1940, with Za Industrializatsiyu of five years earlier - the former is much more like a present-day Soviet paper). On the one hand it played a positive role in mobilising activity , initiating campaigns and exposing poor work. It also provided a platform for Al'perovich and others to propagate the importance of machine tool building and draw attention to its real problems. On the other hand, it also indulged at times in destructive and irresponsible criticism , at times showing a very poor grasp of the real problems involved ,and siezed upon failures in the realisation of difficult tasks as a pretext for generalised negative assessments of the entire work of the industry. One of the worst offenders appears to have been the newspaper, Tekhnika, the technical paper associated with Za Industrializatsiyu . It was this which first raised the attack against the 'DIP' lathe in the spring of 1932 , and its editor ,Kapustin, seems to have had a particularly cynical view of the industry and its achievements. Both Kaganovich and Al'perovich expressed their disapproval of Kapustin and the technical press in general at the First All-Union Conference in June 1933 . The former accused the technical press of hoping for further failures and problems so that it would have grounds for launching more attacks against the technical leadership of industry, while the latter noted wryly that it was quite impossible to argue with Kapustin , because whatever happened he always had the last word¹. The press was thus a powerful social force, but it was not always used wisely.

As the 'thirties a new force developed, which also tended to make to work of the industry more difficult and again its role was ambivalent. This was the pressure exerted by the rising new generation of Soviet trained , politically committed technical specialists. This was a positive phenomenon in so far as it was a sign of the rising strength of the industry , creating conditions for its successful future development. But it had a negative side in so far as these relatively inexperienced new cadres tended to have a very hostile attitude towards foreign experience and what they regarded as the subservience of the industry

1. Stennogrammy..., op cit, pp.230 and 86.

to foreign methods , in particular the practice of copying foreign designs. The urge to create original Soviet designs and new methods was of course creditable, but at a time when even the basic skills of machine tool building had not been assimilated it was premature to expect the industry to take a new, unknown course. The criticisms of these younger specialists tended to mount during the Second Five-year Plan period , and tended to be accentuated by the fact that serious problems were experienced at the time, eg. in building machines for the auto-tractor factories. There is no doubt that this group played a prominent role in the events of 1937; their career interests were congruent with the broad , destructive political process then underway in Soviet society. This is not to deny that these younger designers and engineers later played a considerable role in the development of machine tool building in the USSR, notably during the difficult years of the War.

It is tempting to directly draw lessons from the Soviet experience of creating a machine tool industry for developing countries today, treating the Soviet case as a 'model'. While there are undoubtedly some general guidelines which can be drawn from Soviet experience, it is also essential to realise the different circumstances facing developing countries today , partly stemming from the very successes of Soviet industrialisation. The Soviet Union was forced to develop its machine tool industry in a very short period of time in exceptionally difficult international circumstances. Technical independence from the capitalist world was one of the fundamental aims of the industrial leap forward. But today any country embarking on a genuinely independent (non-capitalist) path of development has the possibility of drawing on the machine tool industries of the Soviet Union and other socialist countries both for imports and technical assistance. This makes feasible a much less intensive , costly and difficult process of development than that experienced in the USSR. The adoption of this path has resulted in the successful creation of strong machine tool industries in a number of East European countries and China, and is today permitting the rapid growth of machine tool building in such countries as North Korea and Vietnam.

A number of development economists have rightly drawn attention to the crucial role of the machine tool industry in the development process¹, and certain features of Soviet experience have been incorporated in United Nations publications and recommendations for industrial growth in the conditions of present-day developing countries. Thus the Soviet practice of the second phase of the industry's evolution of building a narrow range of products on a high seriality basis is thought to have general application², creating a foundation for gradually undertaking the building of a wider range of machines of greater complexity. The Soviet practice of using production-type equipment permitting the employment of workers of a semi-skilled type is also considered to offer benefits in terms of reducing skill requirements.³ The use of special tooling and automatic devices to deskill machine tool building may also have more general application at an early stage of development of the industry as a strategy for overcoming the skill bottleneck.⁴ Finally, one of the characteristic features of the Soviet experience is that it suggests that the use of the most advanced world technology may in some circumstances be a rational course for a backward country striving to rapidly catch up more advanced economies, and may even be an essential condition for doing so, despite the very different initial conditions. Thus the use and production of high-productivity automatic machinery may be a condition for achieving modern levels of industrial development and productivity in certain branches of machine building permitting large-scale production, notably vehicle building.⁵ Such a policy is of course directly at variance with much 'conventional wisdom' of the 1950s and 1960s in the West, which held that countries with a scarcity of capital and plentiful labour should adopt labour intensive technologies.

1. See, for example, Raj.K.N. and Sen.A.K., 'Alternative patterns of growth under conditions of stagnant export earnings', Oxford Economic Papers, Vol.13, 1961, Feb.; Naqvi, R., 'Machine tools and machines: a physical interpretation of the marginal rate of savings', Indian Economic Review, Vol.VII, 1963, Feb.; Atkinson, A.B., 'Import strategy and growth under conditions of stagnant export earnings', Oxford Economic papers, 1969, Nov..

2. Thus, "...when the development of the mechanical industry starts, the demand for machine tools corresponds to elementary types for maintenance and the fabrication of simple articles. As in this stage of development demand is scarcely diversified in types and models, favourable conditions are present for construction in series, above a hundred, for example, which represents a high scale in machine tool manufacture..." - Development of Metal working Industries in Developing Countries, UN, Industrial Development Organisation, New York, 1969, p.130.

3. Report of the Interregional Symposium on Metal Working Industries in Developing Countries, UN, IDO, Vienna, 1968, p.70.

During the brief period 1929 to 1941 the Soviet Union built the foundations of a modern machine tool industry, making a decisive break with past Russian backwardness. Many features established at this time have become essential elements of the industry to this day. Characteristic are the large scale of factories ; the large seriality of production of basic general-purpose models; the use of flow organisation ; the policy of building standard, 'basic' models and unified ranges of machines ; the great stress in general on standardisation; the stress on building unit-construction machines; the structure of R.& D. organisations in the industry, combining a powerful, central institute, ENIMS, with design and development facilities at the enterprise level; the organisation of castings supply from central foundries. At the same time a number of problems having their origin in the early period of development have continued to afflict the industry in the post-War years. Some negative features stemming from the conditions of the 'thirties tended to become institutionalised and difficult to overcome. These shortcomings include the relatively low level of specialised parts production; problems experienced in introducing new models and securing regular design modernisation; an inadequately close relationship between machine tool builders and their customers; problems of securing high quality and reliability; inferior quality semi-fabricates maintaining the hypertrophy of the lathe stock, etc. . But despite these problems and the great difficulties of the early years the development of the Soviet machine tool industry must be rated a considerable success. At the cost of great sacrifices for the Soviet people, a stage of development which in other countries took generations was traversed by Soviet industry in a mere decade. The development of a strong, independent machine tool industry was a vital element in the creation of the technical basis for the defeat of German fascism , and a crucial component of the construction of the economic foundations of the world's first socialist society.

4. "The automatic device can provide those skills which enable the machine tool industry to initiate and continue its operation while the infrastructure of qualified manpower is being built up", *ibid*, p.78.

5. "A developing country has the ability to use automated tools at a faster rate than a developed economy, due to the size, age and greater flexibility of its industrial plant. Although there are major obstacles to automation of both social and economic origin in developing countries, selective automation at the current stage of industrialisation not only can be beneficial, but may be necessary. Automation of the metal-working industries may be the only route to economic survival for developing countries..", *ibid*..pp.70-71.

APPENDICES

1.	The Administration of the Machine Tool Industry and the Enterprises involved in Machine Tool Building.....	437
2.	Variants of the Five-year Plans for Machine Tool Building...	448
3.	The Structure of Machine Tool Installations, 1918-1934.....	458
4.	A Comparison of the Soviet and American Machine Tool Stocks.	483
5.	Military Production and the Demand for Machine Tools.....	497
6.	A Note on 'Continuous Flow' Organisation in the Engineering Industry.....	513
7.	The Machine Tool Building Activities of the Central Institute of Labour.....	521
8.	A Chronology of the Main Events in the Development of the Machine Tool Industry.....	527
	Statistical Appendix.....	530
	Bibliography	585

THE ADMINISTRATION OF THE MACHINE TOOL INDUSTRY AND THE ENTERPRISES
INVOLVED IN MACHINE TOOL BUILDING

Before October 1929 there was no specialised administration for machine tool building. The few factories building machine tools were under different machine tool building trusts which, in turn, were under overall control of Glavmashstroï of VSNKh. Responsibility for machine tool building at this time was vested with the Section of Machine Tool Building attached to the Convention of Syndicates of the Metal Industry, but its powers were limited in so far as it had no direct control over the trusts building the machines. In January 1929 the Presidium of VSNKh acknowledged the necessity of creating an all-Union trust of medium machine tool building and called for the transfer of two enterprises to VSNKh USSR as a step in this direction.¹ Early in May 1929 Glavmashstroï presented a report to STO on the need for the new trust², and the government officially approved it on 29th May.³ The statute of the State Trust of Medium Machine Tool Building, 'Stankotrest', was approved by VSNKh in June; it was to be composed of three factories - 'Krasnyi Proletarii', im. Sverdlova and 'Dvigatel' Revolyutsii' - and have an initial capital of 18.9 million rubles.⁴ The new trust started work on 1st October under the chairmanship of E.M. Al'perovich. Shortly before this Glavmashinstroï approved the formation of an all-Union tooling industry trust, and this appears to have started work in the autumn of 1929.⁵ Also, at the end of September 1929 Glavmashinstroï approved the creation of a special construction organisation for building new machine tool factories, 'Stankostroï' trust, which at first was organisationally independent of 'Stankotrest'. According to the VSNKh decree of 11th January 1930 Stankostroï was under Orgametall and had responsibility for projecting, building and putting into operation the new factories.⁷ This arrangement was clearly unsatisfactory for Stankotrest, which early in 1930 decided to open negotiations for the transfer of Stankostroï from Orgametall.⁸

In January 1930 Glavmashstroï was replaced by a new all-Union Ob"edinenie of the machine building industry, Mashinob"edinenie, which incorporated many

1. Torg.-prom.gaz, 26.1.1929.

2. Ibid., 11.5.1929.

3. Alzenshtadt and Chikhachev, op cit, p.194.

machine building trusts, including Stankotrest.¹ But shortly after this it was decided to further decentralise industrial administration by creating a series of ob"edineniya for the main branches of the engineering industry. A decree of STO of 2nd April 1930 approved the formation of the All-Union Ob"edinenie of the Machine Tool Building and Tooling Industry.² There is some confusion in the literature about this event and reference at the time to the possibility of an ob"edinenie for the boiler-turbine and machine tool industries³. However a meeting of the Presidium of VSNKh of 8th April favoured the formation of Soyuzstankoinstrument, as the new body became known, incorporating Stankostroi.⁴ Its statute was approved on 26th May 1930 ; it was to have an initial capital of 55 million rubles and its rights were greater than for the previous trust, notably with respect to the sale of machine tools and tooling.⁵ Al'perovich was appointed chairman of the new organisation, which began work in mid-June.⁶

Until September 1930 Soyuzstankoinstrument only had responsibility for machine tool building at its own enterprises, with no rights in relation to other enterprises and organisation which began to play an increasing role in machine tool building at this time. A decree of the Presidium of VSNKh USSR of 16th September 1930 attempted to change this situation. The decree set out a number of rules for planning production and construction, and procedure for the sale of machine tools built by other ob"edineniya. The planning of production was to be undertaken by Soyuzstankoinstrument within the limits of a nomenclature which it also established, with the agreement of the organisation concerned (or VSNKh if no agreement could be reached). Soyuzstankoinstrument was to concentrate data on the machine tool needs of the economy and on the production possibilities of the various machine tool building shops and factories. It was also to agree the drafts of long term plans and control figures presented to VSNKh by the other ob"edineniya in so far as they related to machine tool building, and to participate in the work of VSNKh and other higher government organisations in elaborating plans and control figures for all machine tool production. Advice on the choice

4. Sobranie zakonov i rasporiazhenii, 1929, pt. 2, (30), p. 696.

5. Ek.zhizn', 26.9.29.

6. Khar'kovskii stankostroitel'nyi, op cit, p. 6.

7. Sti, 1934, No. 10, p. 5.

8. Syulleten' Stankotrest, 1930, No. 2-3, p. 69.

1. ZaInd., 11.1.30, 24.1.30.

of types and designs was to be provided by Soyuzstankoinstrument, which was also to approve types and designs of machines to be built on a serial or mass basis within the programme established by the control figures. Finally, the selling of all machine tools was to be exclusively the concern of Soyuzstankoinstrument. Prices were to be fixed by the ob"edinenie with the agreement of the other parties concerned. This decree gave Soyuzstankoinstrument quite considerable rights in relation to other ob"edineniya, although significantly the requirements for supply of information were much less stringent for military enterprises, and whereas Soyuzstankoinstrument could now directly investigate production at other factories, this right did not apply to the machine tool building of the defence ob"edineniya? This attempt to extend central control was not entirely successful. A later commentator observed that the granting of the right to plan the production of factories of other ob"edineniya did not give positive results.⁸ But the system whereby Soyuzstankoinstrument took responsibility for the sales of all machine tools produced became a feature of the industry from this time on. Later, a special organisation was created within the machine tool administration for handling this work - Stankoinstrumentsbyt (date of formation not known). It was this body which issued catalogues and price lists for the whole industry.

In July 1931 SNK USSR issued a decree calling for the splitting up of Soyuzstankoinstrument into separate ob"edineniya for the machine tool and tooling industries.⁹ This measure was not immediately realised, and it took a later SNK action in December to make the leadership of the industry carry out this division.¹⁰ By the end of the year two separate all-Union ob"edineniya had been formed for machine tool building and the tooling abrasives industry. Earlier in the autumn a new glavk with overall responsibility for the machine building and metalworking industry was created within the structure of VSNKh. The new organisation, Glavmashprom was under the chairmanship of M.M.Kaganovich, with Kritsman and Dotsenko as deputies.¹¹

2. ZaInd., 25.5.1930.

3. ZaInd., 6.4.1930. This source claims that STO supported this proposal.

4. Kuznetsova, N.V., *Bor'ba rabocheho klassa...*, op cit, *after referat*, p.9.

5. *Sobranie zakonov*, 1930, No.39, p.218.

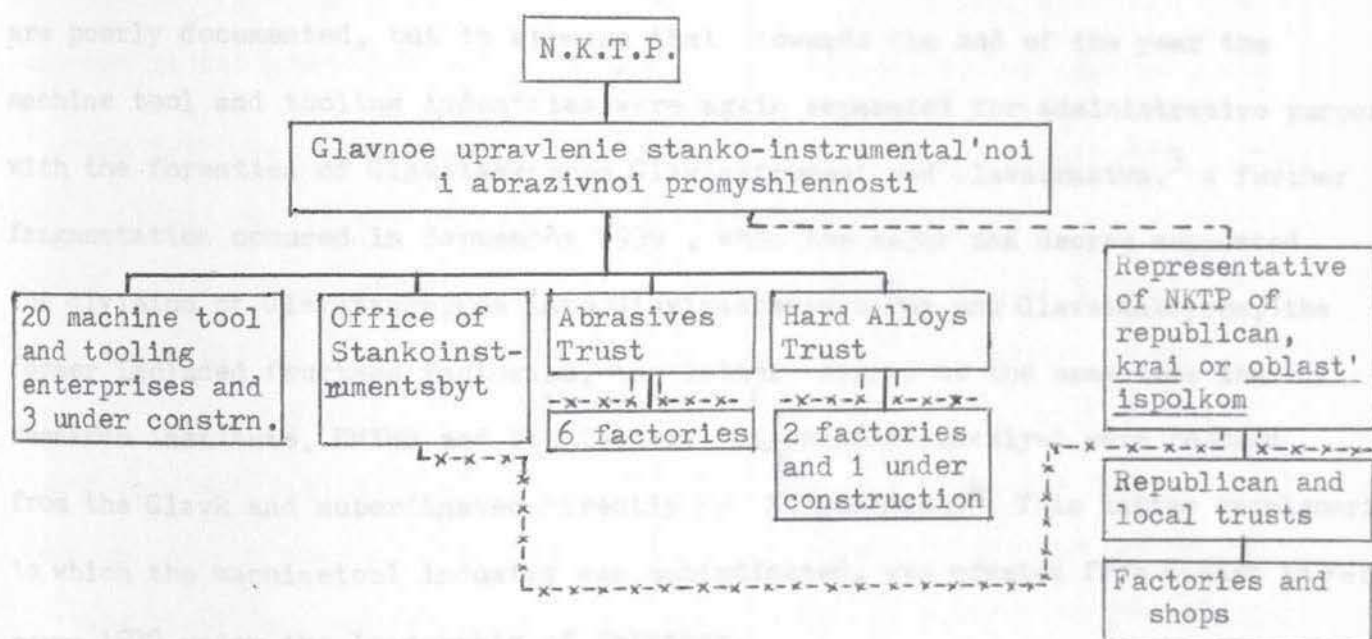
6. *Sbornik postanovlenii i prikazov po promyshlennosti*, VSNKh, 1929/30, No.50, art.1521.

7. *ibid.*, No.93, Art.1396, decree of 16.9.1930.

8. *Planovoe khozvaistvo*, 1934, No.3, p.95.

The next change in the administration of the industry came in August 1933. A decree of SNK USSR of 31st August called for the creation of a new glavk uniting the machine tool and tooling ob"edineniya¹. This measure was part of a broader process involving the breaking up of Glavmashprom of NKTP, and gave rise to a two-tier system as opposed to the previous three-tier structure. Now the new machine tool and tooling glavk, GUSIP for short, was directly subordinated to NKTP. The structure of GUSIP soon after its formation was as shown:

The Structure of Glavstankoinstrumentprom



— lines of subordination and planning

- - - lines of planning only

-x-x-x-x sales only

Source: Sakharov, G.; Chernai, N.; Kabakova, O., Ocherki organizatsii tyazheloi promyshlennosti SSSR, M., 1934, p. 83.

As can be seen GUSIP had some responsibilities in relation to planning the machine tool building activities of factories and shops of republican and local organisation. This was part of the general responsibility which the industry maintained from 1930 for machine tool building throughout the economy. Within the Glavk there was

9. Venediktov, A. B., Organizatsiya gosudarstvennoi promyshlennosti v SSSR, L., 1961, Vol. 2, p. 565; ZaInd., 20.7.31.

10. ZaInd., 4.12.1931.

11. Ek. zhizn', 19.9.31.

1. Sobranie zakonov, 1934, No. 58, p. 346.

an office for the 'planned' factories, as they became known, of other organisations. GUSIP appears to have had some say in the fixing of output plans and in the establishment and approval of the range of types and sizes to be built by all factories and shops of heavy industry. These were rights were granted by the NKTP order of 16th June 1933.¹ It seems likely that GUSIP's powers in this respect were weakened at the end of 1936 when the branches of the defence industry left NKTP to form a separate commissariat.

In August 1937 the machine building sector of NKTP split off to form a new commissariat of machine building, which included GUSIP.² Developments in 1938 are poorly documented, but it appears that towards the end of the year the machine tool and tooling industries were again separated for administrative purposes with the formation of Glavstankoprom, Glavinstrument and Glavabraziva.³ A further fragmentation occurred in September 1939, when the major SNK decree supported the division of Glavstankoprom into Glavtyazhstankoprom and Glavstankoprom, the former included fourteen factories, the latter eight. At the same time the research institute, ENIMS and its factory 'Stankokonstruktsiya' were removed from the Glavk and subordinated directly to NKTyazhMash.⁴ This latter commissariat to which the machinetool industry was subordinated, was created from NK Mash in February 1939, under the leadership of Malyshev.

During the Third Five-year Plan some measures were taken to improve the work of non-specialised machine tool building enterprises. In September 1936 an All-Union Technical Office, 'Stankinprom' had been created within the structure of GUSIP for providing technical assistance to enterprises of the Glavk, in particular those newly transferred from other branches and new enterprises. Its work primarily consisted of planning technological processes; by the War it had a total of about 120-130 workers.⁵ The September 1939 SNK decree called for the organisation of an Administration for Non-specialised Machine Tool Factories (UNZ) on the basis of Stankinprom, in order to provide technical assistance to these enterprises and also for undertaking planning work in relation to their machine tool building activities.⁶ The UNZ of NKTyazh Mash was created, but it is not known whether it was in fact founded on Stankinprom. At the Fifth Conference of machine tool

designers in April 1940 the head of UNZ, Aravin, complained that planning of new models in this sector was inadequate; ^{only} six new types and sizes had been introduced during 1939, and many of the UNZ factories had no designers even though they built thousands of machine tools a year.⁷ The September 1939 decree also gave NKTyazh Mash responsibility for leading work on establishing the tipazh for all machine tool building of other commissariats, and laid down that new designs of machine tools to be built at all factories of other commissariats had to be approved by Ekonomsovet of SNK USSR.⁸ Thus, in 1939 there were attempts to reestablish central control of all machine tool building in the country, which had been weakened in the preceding three years by the fragmentation of commissariats.

From 1929 when Stankotrest had been formed to 1939 the importance of machine tool building had steadily grown and the industry had gradually acquired greater strength as an administrative unit. In 1940 and early 1941 the industry formed a major component of NKTyazhMash, which from April 1940 was headed by A.I. Efremov, a former machine tool industry worker.⁹ In June 1941 the new status of the branch received full recognition. By a government decree of the 5th a new People's Commissariat of Machine Tool Building USSR was created, uniting the previously separate glavki of machine tool building, tooling, abrasives and the building of metal-forming equipment.¹⁰ The NK Machine Tool Building was headed by Efremov. It proved to be short-lived. In November 1941 it was disbanded and the machine tool and tooling factories transferred to military commissariats, but this emergency wartime measure was reversed in February 1942.¹¹ The Commissariat, renamed Ministry in 1946, retained its independent existence from then on until the Sovnarkhoz reform in the 1950s.

The changing administrative structure of the industry between 1929 and 1941 is summarised in the chart on the following page.

1. Industrializatsiya SSSR, 1933-1937, op cit, p.249.

2. ZaInd., 23.8.37.

3. There are references to these glavki in Mashinostroitel', 1938, No.11, p.2 & 1939, No.

4. Direktivy KPSS..., op cit, Vol.2, pp.604-606.; Mashinostroenie, 12.11.1939.

5. Gosudarstvennyi proektno-tekhnologicheskii i eksperimental'nyi institut

Orgstankinprom, 1936-1961, M., 1961, pp.3-4.

6. Direktivy KPSS..., op cit, p.605.

7. Mashinostroenie, 10.4.1940.

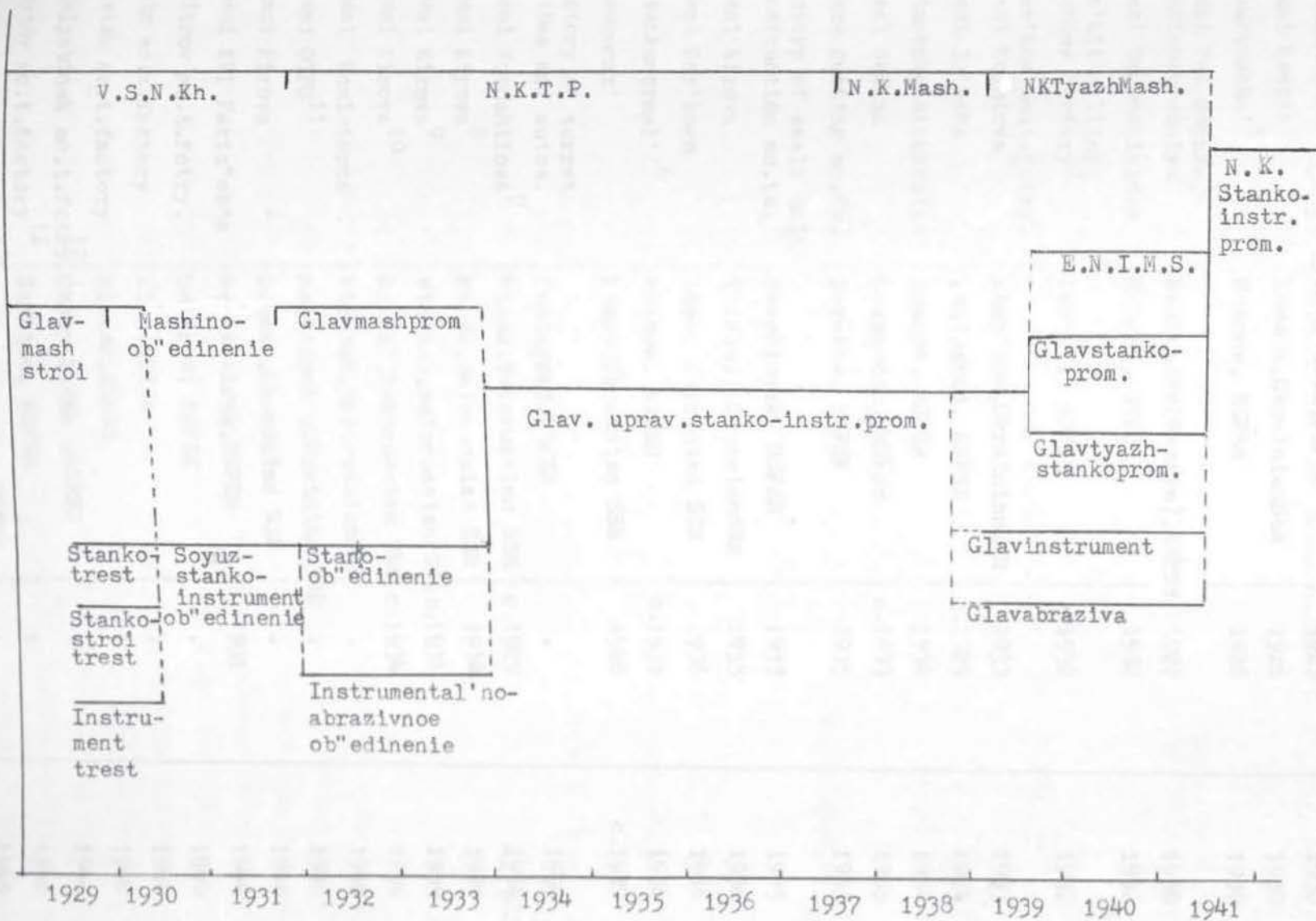
9. Mashinostroenie, 18.4.1940.

11. Zinich, M.S., Istoricheskie zapiski, No.85, 1970, pp.11 and 15.

8. Direktivy KPSS, op cit, p.605.

10. SiI, 1947, No.11, p.20; Zhed', op cit, p.16.

The Administration of the Machine Tool Industry, 1929 - 1941



Enterprises temporarily under the machine tool industry administration

a. 'Dvigatel' Revolyutsii'	Gor'kii, RSFSR	Pre-Rev/c.1921	1929 - 1930
b. imeni F. Dzerzhinskogo	Perm (Molotov), RSFSR	1931	1931 - 1932

Notes

1. Renamed in 1936-37 - Moscow (surface) grinding machine factory; also known as, Moscow machine tool building factory.
2. Later renamed, Srednevolzhskii machine tool factory.
3. From about mid-1930s known as, imeni L.M. Kaganovicha.
4. Later (post-War) renamed, imeni Kosiora.
5. On the site of the Sverdlovsk heavy machine tool factory - took this name by 1940.
6. Also known as, the factory of internal grinding machines. Former Remmashtrest works
7. In 1920s known as 'Energiya', later (post-War) renamed, imeni Oktyabr'skoi Revolyutsii.
8. Until 1934 known as 'Kommunar'.
9. Full name pre-War, 'Krasnyi Metallist' imeni Kirova.
10. Formerly, 'Proletarii'.
11. Former NKZem factory, later (1944) renamed, imeni 23 oktyabrya.
12. Former NKVD labour communes.

Sources - for date of entry into specialised industry.

- 1., 2. - TPG, 29.6.29.
- 3., 4., 5., 6. - ZaInd., 16.11.30.
- 7., 8. - Zhed', op cit, p12.
9. - assumed 1933 as this was year production started - Kkar'kovskii stankostroitel'nyi, op cit, p12.
10. - Leningradskaya promyshlennost' za 50 let, op cit, p229.
11. - Aizenshtadt & Chikhachev, p218.
12. - 50 let Krasnodarskii stankostroitel'nyi, op cit, p43.
13. - A. & Ch., p218.
14. - Ibid.
15. - Istoriya industrializatsiya Gruzhiinskoi SSR, 1926-41, op cit, p822.
16. - A. & Ch., p218.
17. - SII, 1936, No. 8, p1.
18. - No specific reference, but known to have been between 1936 and 1939, and makes known total of 18 specialised enterprises in 1937.
19. - Leningradskaya promyshlennost', op cit, p436.
- 20., 21., 22., 23. - Zhed', op cit, p15.
24. - 33. - A. & Ch., xxxxxx, p.220.
- a. - TPG, 29.6.29; Prob. Ek., 1935, No4, p195.
- b. - Lebyachenko, op cit, p7.

The number of specialised factories in each year is shown in Table, A1.1, p.441. The data coincides with that of Soviet sources up to and including 1939 (23 specialised enterprises - Mashinostroenie, 10.12.39.), but diverges for 1940, possibly because enterprises which should have been transferred to the branch in 1940 were transferred later. (Nos. 24-33 above). Totals given for 1940 are 29 (Zabelin, B.M., Kontsentratsiya i spetsializatsiya promyshlennosti v usloviakh reformy, M., 1970, p9) and 31 (calculated from Omarovskii, op cit, p70). Some sources give a total of 37 specialised factories by the War (Zhed', op cit, p12; Aizenshtadt and Chikhachev, p220); this is difficult to reconcile with known facts and it is possible that some allied or tooling factories of the Ministry of Machine tool Building are included.

Enterprises of the Defence Industry Building Machine Tools

Name of Enterprise	Location	Year started machine tool building (approx.)
1. Tula Arms Factory	Tula, RSFSR	Pre-Revn/ 1922
2. Izhevsk steel foundry and gun factory	Izhevsk, RSFSR	1927
3. imeni Kalinina artillery factory	Leningrad, RSFSR	1930
4. Factory No. 25 aircraft factory	Moscow, RSFSR	1932
5. imeni Dzerzhinskogo ¹	Perm', RSFSR	1931
6. Factory No. 60	Lugansk (Voroshilovgrad) RSFSR	1933
7. imeni Frunze, No. 50	Penza, RSFSR	1934
8. imeni Volodarskogo	Ul'yanovsk, RSFSR	1934
9. FZU, imeni Maslennikova factory	Kuibyshev, RSFSR	1934
10. Podol'sk factory No. 17 ²	Podol'sk, RSFSR	1935
11. imeni K. Libknekhta	Leningrad, RSFSR	1937
12. OZPO factory	Vladimir, RSFSR	1938
13. Ts. I. T. machine tool factory No. 1 ³	Moscow, RSFSR	1932
14. Molotov tekhnikum	Perm' (Molotov) RSFSR	1938

In addition, there were a number of FZU Schools and technicums of the defence industry which built machine tools at various times.

Note - not all the above enterprises built machine tools throughout the period indicated - a number appear to have ceased during the Third Five-year Plan.

Notes

1. In the specialised machine tool industry for about a year, apparently transferred to the defence industry in 1932.

2. Apparently based on the sewing machine factory at Podol'sk

3. Transferred to the aircraft industry in 1938.

Sources - compiled from catalogues, price handbooks and other sources.

Some other enterprises building machine tools on a regular basis

Name of Enterprise	Location	Year started machine tool building (approx.)
1. im. Voskova tooling factory	Sestroretsk, RSFSR	1934
2. Zlatoust tooling factory	Zlatoust, RSFSR	1st FYP
3. 'Frezer' im. Kalinina tooling factory	Moscow, RSFSR	1933
4. Uralsmashzavod heavy mc. bldg. factory	Sverdlovsk, RSFSR	c. 1935
5. Kramatorsk im. Stalina heavy mc. bldg. f.	Kramatorsk, Ukrainian SSR	c. 1935
6. Azstankostroi No. 1	Baku, Azerbaidzhanian SSR	1st FYP
7. Azstankostroi No. 2	Baku, Azerbaidzhanian SSR	1st FYP
8. imeni Kamo	Tbilisi, Georgian SSR	c. 1936
9. 'Krasnyi Put'	Kazan', RSFSR	c. 1934
10. 'Rekord'	Grim, German Volga ASSR	c. 1934
11. im. Karla Marksa textile mcy. f.	Leningrad, RSFSR	1st FYP

Source - as above.

Enterprises of the Defence Industry Building Machine Tools

Name of Enterprise	Location	Year started machine tool building (approx.)
1. Tula Arms Factory	Tula, RSFSR	Pre-Revn/ 1922
2. Izhevsk steel foundry and gun factory	Izhevsk, RSFSR	1927
3. imeni Kalinina artillery factory	Leningrad, RSFSR	1930
4. Factory No. 25 aircraft factory	Moscow, RSFSR	1932
5. imeni Dzerzhinskogo ¹	Perm', RSFSR	1931
6. Factory No. 60	Lugansk (Voroshilovgrad) RSFSR	1933
7. imeni Frunze, No. 50	Penza, RSFSR	1934
8. imeni Volodarskogo	Ul'yanovsk, RSFSR	1934
9. FZU, imeni Maslennikova factory	Kuibyshev, RSFSR	1934
10. Podol'sk factory No. 17 ²	Podol'sk, RSFSR	1935
11. imeni K. Libknekhta	Leningrad, RSFSR	1937
12. OZPO factory	Vladimir, RSFSR	1938
13. Ts. I. T. machine tool factory No. 1 ³	Moscow, RSFSR	1932
14. Molotov tekhnikum	Perm' (Molotov) RSFSR	1938

In addition, there were a number of FZU Schools and technicums of the defence industry which built machine tools at various times.

Note - not all the above enterprises built machine tools throughout the period indicated - a number appear to have ceased during the Third Five-year Plan

Notes

1. In the specialised machine tool industry for about a year, apparently transferred to the defence industry in 1932.

2. Apparently based on the sewing machine factory at Podol'sk

3. Transferred to the aircraft industry in 1938.

Sources - compiled from catalogues, price handbooks and other sources.

Some other enterprises building machine tools on a regular basis

Name of Enterprise	Location	Year started machine tool building (appr)
1. im. Voskova tooling factory	Sestroretsk, RSFSR	1934
2. Zlatoust tooling factory	Zlatoust, RSFSR	1st FYP
3. 'Frezer' im. Kalinina tooling factory	Moscow, RSFSR	1933
4. Uralsmashzavod heavy mc. bldg. factory	Sverdlovsk, RSFSR	c. 1935
5. Kramatorsk im. Stalina heavy mc. bldg. f.	Kramatorsk, Ukrainian SSR	c. 1935
6. Azstankostroi No. 1	Baku, Azerbaidzhanian SSR	1st FYP
7. Azstankostroi No. 2	Baku, Azerbaidzhanian SSR	1st FYP
8. imeni Kamo	Tbilisi, Georgian SSR	c. 1936
9. 'Krasnyi Put'	Kazan', RSFSR	c. 1934
10. 'Rekord'	Grim, German Volga ASSR	c. 1934
11. im. Karla Marksa textile mc. f.	Leningrad, RSFSR	1st FYP

Source - as above.

Machine Tool Building Enterprises , 1925 - 1940.Table A1.INumber of Enterprises Building Machine Tools
(end of year)

Year	Specialised Machine Tool Industry	Defence Industry*	Other Enterprises*	Total Number of Enterprises*
1925	-	1	3	4
1926	-	1	6	7
1927	-	2	8	10
1928	-	2	9	11
1929	3	2	8	13
1930	6	3	7	16
1931	7	3	10	20
1932	8	5	11	24
1933	9	6	13	28
1934	11	9	21	41
1935	14	10	24	48
1936	17	10	31	58
1937	18	11	35	64
1938	18	13	39	70
1939	23	13	42	78
1940	33	13	40	86

* Approximate

Sources

1. Specialised, see p.
2. Defence industry - based on information from catalogues, price handbooks, factory histories and other sources.
3. Other - as 2.
4. Total - as 2, plus following additional evidence:
 - 1927 - 10 , Ek.Zhizn', 19.5.29.
 - 1928 - 11 , Bol'shevik, 1935, No.6, p11.
 - 1930 - 16 , ibid.
 - 1933 - 28 , 9 spzd., plus 19 'planned' - Aizenshtadt & Chikhachev , p218.
 - 1934 - 41 , as 1928.
 - 1935 - 48 , ibid.
 - 1936 - 41 , more than 40 - ZaInd, 1.9.36.
 - 1937 - 64 , 18 spzd., plus 46 'planned', Aizenshtadt & Chikhachev, p218.
 - 1940 - 86 , based on 1940-41 price handbook.

Appendix Two

VARIANTS OF THE FIVE-YEAR PLANS FOR MACHINE TOOL BUILDINGThe First Five-year PlanVariant I For five years , 1926/27 - 1930/31

(May 1926)

Machine tool needs: 30 m.r. a year for five years ,i.e.150 m.r. (including metal forming machines)

Output in final year: 28.8 m.r.; including 12 m.r. from three main factories ('Krasnyi Proletarii', im.Sverdlova, 'Dvigatel' Revolyutsii); 5.6 m.r. Kramatorsk (forming machines); 11.2 m.r. from two new factories.

Construction plan: Reconstruction of existing factories, plus construction of two new - one in Sverdlovsk (Uralsmashzavod) for metal forming machines, one in the South , primarily for needs of railway workshops.

Variant II For five years, 1927/28 - 1931/32 (apparently an amendment of I)

(March 1927)

Machine tool needs and output , cutting machines only: (million rubles)

	1927/28	1928/29	1929/30	1930/31	1931/32	Total
Needs	17.98	20.28	22.50	24.80	27.00	112.6
Output	6.78	8.70	10.78	13.50	19.20	59.0
Per cent of needs met	37.7	42.9	47.9	54.4	71.1	52.4

Total needs including forming machines 150 m.r. ; total output 83.1 m.r..

Output in final year to be composed of: 11.5 m. from the three main factories; 5.6 m.r. Kramatorsk; two new factories - 6.2 m.r.; local factories 4.9 m.r.

Construction plan: Reconstruction of existing factories; construction of two new factories in the South and in Sverdlovsk; development of a number of small factories having experience of machine tool building.

This variant was still in force in May 1928.

Variant III For five years, 1928/29 - 1932/33. This appears to have been VSNKh's final variant of the Control Figures for the Five-year Plan.

(October 1929)

Total machine tool (cutting) needs over five years: not known.

Output plan: not known.

Construction plan: Specialisation and reconstruction of the three main factories; building of 5 new small enterprises, with a capacity of 4 - 5 m.r. output each.

Variant IV For five years, 1928/29 - 1932/33. The Five-year Plan as adopted in April 1929.

(April 1929)

Planned needs over five years: 152 m.r..

Output plan: not known.

Construction plan: Two new factories to be built - in Moscow (cost of construction 15 m.r.) and Khar'kov (10 m.r.). Also a possible third (forming? in the Urals. Major reconstruction at the three main factories, and the specialisation and development of a number of existing smaller works.

Variant V Revised Five-year Plan.

(May 1929)

Planned needs over five years: about 300 million rubles, including 84 m.r. in the final year, 1932/33.

Output plan: Final year output of 53 m.r., including 22.5 m.r. from the three main factories. In final year 62 per cent of needs to be met from domestic production.

Construction plan: Five new factories to be built.

Variant VI There appear to have been several proposals for changes in the revised Plan adopted in May during the autumn of 1929. Details are known only of the following variant:

(August/September ? 1929)

Planned needs : Approx. 85 m.r. in 1932/33.

Output plan : Final years output of 81.5 m.r., including 38.5 m.r. from existing factories, and 43 m.r. from new factories. Output in 1931/32 - 45 m.r.

Construction plan: Ten new factories to be built, with a total capacity of 64 m.r., giving an output of 43 m.r. in the final year.

There is reference to the existence of a final year target of 86m.r. at the time of the next revision in January 1930.

Variant VII

(January 1930)

This revision appears to have been based on the following estimate of needs presented by Gipromez:

	1928/29	1929/30	1930/31	1931/32	1932/33	Total
Needs, value (mr)	42.0	71.1	105.7	121.1	144.1	484
Needs, units	9,550	16,150	24,030	27,520	32,750	110,000

Value per unit - 4,400r.

Output plan: End of plan period aim of 150 m.r. (in import prices), compared with 86 m.r. (in 1926/27 prices) previously accepted. Later in 1930 the following output plan was adopted, apparently based on this new final year target:

	1928/29	1929/30	1930/31	1931/32	1932/33
Output, m.r.	9.0	17.1	32.1	49.0	n.a.
Per cent needs met	21.4	24.1	30.3	40.5	

Construction plan: about ten new factories to be built; three in 1929/30 for operation by the end of 1930/31. Capacities of these three factories raised compared with previous December.

Variant VIII

In July 1930 Kaganovich referred to a final year output target of 150 m.r., and planned needs in that year of 250 m.r., i.e. 60 per cent satisfaction.

(December 1930)

Machine tool needs and output plan:

	1928/29	1929/30	1930/31	1931/32	1932/33	Total
Needs, ('000r)	61,650	129,000	189,975	219,300	270,900	878,925
Needs, units	9,600	20,000	29,455	34,000	42,000	135,055
Output ('000r)	7,700	17,100	32,100	67,000	152,100	275,000
Per cent needs met	12.25	13.19	17.39	30.9	56.1	31.3

Value per unit - 6,450r.

This appears to have been the final plan variant.

Variant V

(Feb.1933, Al'perovich)

Output of all machine tool building factories, presumably NKTP only.

	1933	1934	1935	1936	1937	Total	1933-7 inc. %
Units	13397	16467	21350	26850	32150	110214	240
Value (m.r.) (1926/27 p.)	94.1	128.7	180.2	237.5	298.0	938.5	317
Value/ unit(r)	7030	7800	8450	8840	9280	8515	132

Variant VI

(May,1933 , Al'perovich)

Output of Stankoob"edinenie factories in 1937 - 15,000 units.

Variant VII

(December ,1933, Theses of Molotov and Kuibyshev on the Second Five-year Plan)

Output in 1937 to be 40,000 units (NKTP) (cf.15,000 units in 1932)

Increase of output 1932-37 - 267 per cent.

Variant VIII

(January 1934, NKTP Order of 23.1.1934)

	1934	1935	1936	1937	Total	1933-7 inc. %
GUSIP (units)	8372	13600	21550	30800	74822	347
Defence factories	4965	7145	8850	10750	31710	217
Other 'planned' factories	5635	7315	8950	10650	32550	189
Total Output	19472	28060	39350	52200	139082	268

Variant IX

(Feb.1934, The final Second Five-year Plan)

Output , NKTP factories:

	1932	1933	1934	1935	1936	1937	Total	1933-7 inc. %
Units	15000	15400	19000	24000	31000	40000	129400	260
Value(m.r.)	76.9					400	(1200-1300)	
Value/unit	5127r.					10000	(9660)	

(..) estimate

Fulfilment of the First Five-year Plan¹

Output: marketed output in 1926/27 prices, million rubles:

	1928/29	1929/30	Sp.Q. 1930	1931	1932	1933	Total
Specialised factories	7.0	14.0	4.5	18.5	32.8	47.4	124.2
Other factories	3.4	6.0	2.1	15.2	46.8	54.8	128.3
Total output	10.4	20.0	6.6	33.7	79.6	102.2	252.5

Total Machine Tool Supply - domestic production plus imports (million rubles)

	1928/29	1929/30	Sp.Q. 1930	1931	1932	1933	Total
Imports ²	(16.7)	(41.9)	(16.3)	107.1	97.1	38.6	317.7
Total supply	27.1	61.9	22.9	140.8	176.7	140.8	570.2
Per cent domestic prodn.	38.4	32.3	28.8	23.9	45.0	72.6	44.3

Output and total supply in units terms:

	1929	1930	1931	1932	1933	Total
Output(ex.simple mcs.)	(4500)	(8200)	16658	17666	18501	62525
Imports	5000	9000	14000	12000	7746	47746
Total supply	9500	17200	30685	29666	26247	113271
Per cent domestic prodn.	47.4	47.7	54.3	59.5	70.5	57.8

(..) estimate on basis of calendar year data.

1.1933 added for comparability with Plans.

2.The series used at the time, including some non-machine tool items - for comparability with Plans.

Sources:

- Variant I : Byulleten' konventsii..., 1925-26, No.10-12, pp.154-158; Sistema i organizatsiya, 1926, No.4, pp.10-13.
- Variant II : Metall, 1927, No.6, pp.74-76.
- Variant III : Torg.-prom.gaz., 27.10.28; EK.zhizn', 4.1.29.
- Variant IV : Sotsialisticheskaya ratsionalizatsiya..., op cit., p.173; Pyatiletnii plan..., op cit., Vol.1, 2nd.edn., p.46.
- Variant V : Sotsialisticheskaya ratsionalizatsiya..., op cit., p.173; Torg.-prom.gaz., 12.5.29; EK.zhizn', 19.5.29.
- Variant VI : Aralov, S.I.; Shatkhan, A.S., Promyshlenniy import, op cit, pp.26 & 142.
- Variant VII : Needs-Izvestiya, 10.5.30; SiI, 1930, No.3-4, p.2; Output-Izvestiya, 25.6.30; ZaInd., 15.7.30; Construction - Izvestiya, 10.5.30.
- Variant VIII : Pravda, 13.12.30; July - ZaInd., 24.7.30; 150m.r. also Zhibarev, op cit, p.27.
- Fulfilment : Output - Tables SA.I ; Imports - Table SA.XVI and Vneshnyaya torgovlya SSSR za 1918-1940gg., M., 1960, p.269.

Output - million rubles

150

100

70

50

30

20

10

1927/28

1928

1928/29

1929

1929/30

1930

1930/31

1931

1931/32

1932

1932/33

1933

VIII
12/30

ACTUAL
TOTAL

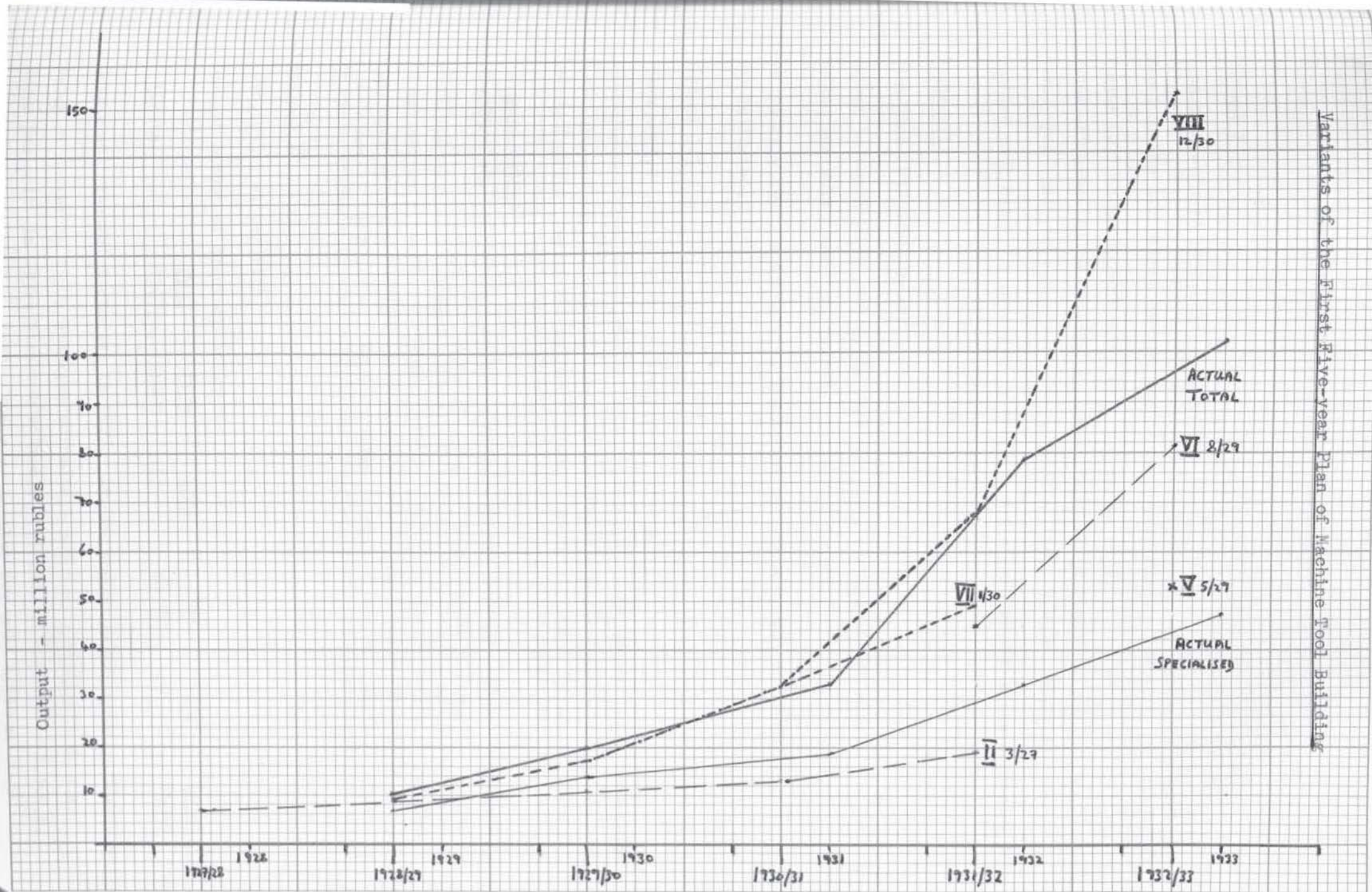
VI 8/29

x V 5/29

ACTUAL
SPECIALISED

VII 4/30

II 3/29



The Second Five-year Plan, 1933-1937

Variant I

(Jan. 1932 - June? 1932; Al'perovich)

Based on the directives of the Second Five-year Plan.

Output 1937 to be 80,000 units (cf. 22,000 in 1932)

Value of Output to be 640-650 m.r. (cf. 76 m.r. in 1932)

Value per unit to average 8,000 r. in 1937 (cf. 3,450r. in 1932)

Machine tool stock to increase by 400,000 units (cf. 200,000 units beginning 1932)

Variant II

(1st June 1932 NKTP Order)

Output to reach 70-80,000 units in 1937, and a value of 750 m.r.

Value per unit 10,000 r. approx.

At the July 1932 Conference of Designers an output target of 72,000 units was indicated.

Variant III

(Sept.-Oct.? 1932, Zernov - Stankoob"edinenie)

	1932	1933	1934	1935	1936	1937	Total
Needs (units)	85000	40000	45000	55000	65000	75000	280,000
<u>Planned output</u>							
Stankoob"ed.	11000	15000	24500	36000	49000	57900	182,400
Other	13000	4400	5000	8000	10500	11350	39,250
Total output	24000	19400	29500	44000	59500	69250	221,650
Per cent of needs met	28.2	48.5	65.6	80.0	91.5	92.3	79.2

Variant IV

(Jan. 1933, Al'perovich)

Planned output of Stankoob"edinenie:

	<u>1933</u>	<u>1934</u>	<u>1935</u>	<u>1936</u>	<u>1937</u>	<u>Total</u>	<u>1933-7</u> <u>Inc. %</u>
(Units)	7307	11000	15000	20000	26000	79397	356

Output of 'Planned' factories in 1937 - 14,000 units; Total output - 40,000 units.

Value of output in 1937: Stankoob"edinenie - 305 m.r.; 'Planned' - 91 m.r.

Value per unit in 1937: Stankoob"edinenie - 11750r.; 'Planned' - 6,500 r.

Total value of output in 1937 - 396 m.r.; value per unit 9,900 r.

Fulfilment of the Second Five-year Plan (units)

	1933	1934	1935	1936	1937	Total
<u>1. NKTP</u>						
Five-year Plan	15400	19000	24000	31000	40000	129400
Annual Plans	n.a.	19000	19800	23905	30000	
Actual Output	(13000)	15900	19378	23624	(26000)	(97900)
Per cent fulfilment (FYP)	(84.4)	83.7	80.7	76.2	(65.0)	(75.7)
<u>2. GUSIP plus 'Planned'</u>						
Actual Output	18501	21131	24872	32408	36120	133032
As per cent NKTP FYPlan*	120.1	111.2	103.6	104.5	90.30	102.8
<u>3. GUSIP</u>						
Actual Output	7838	8304	10100	13288	15785	55315

(..) estimate

* In the course of the Plan period this total increasingly began to displace that for NKTP in measuring the success achieved in fulfilling the Five-year Plan.

Sources

Variant I : SiI, 1932, No. 2, p. 2; ZaInd., 2.1.32.

Variant II : SiI, 1932, No. 7, p. 2; SiI, 1933, No. 1, p. 6.

Variant III : Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No. 9-10, p. 83.

Variant IV : SiI, 1933, No. 1, p. 1.

Variant V : SiI, 1933, No. 2, p. 1.

Variant VI : SiI, 1933, No. 4, p. 1. (issued in May).

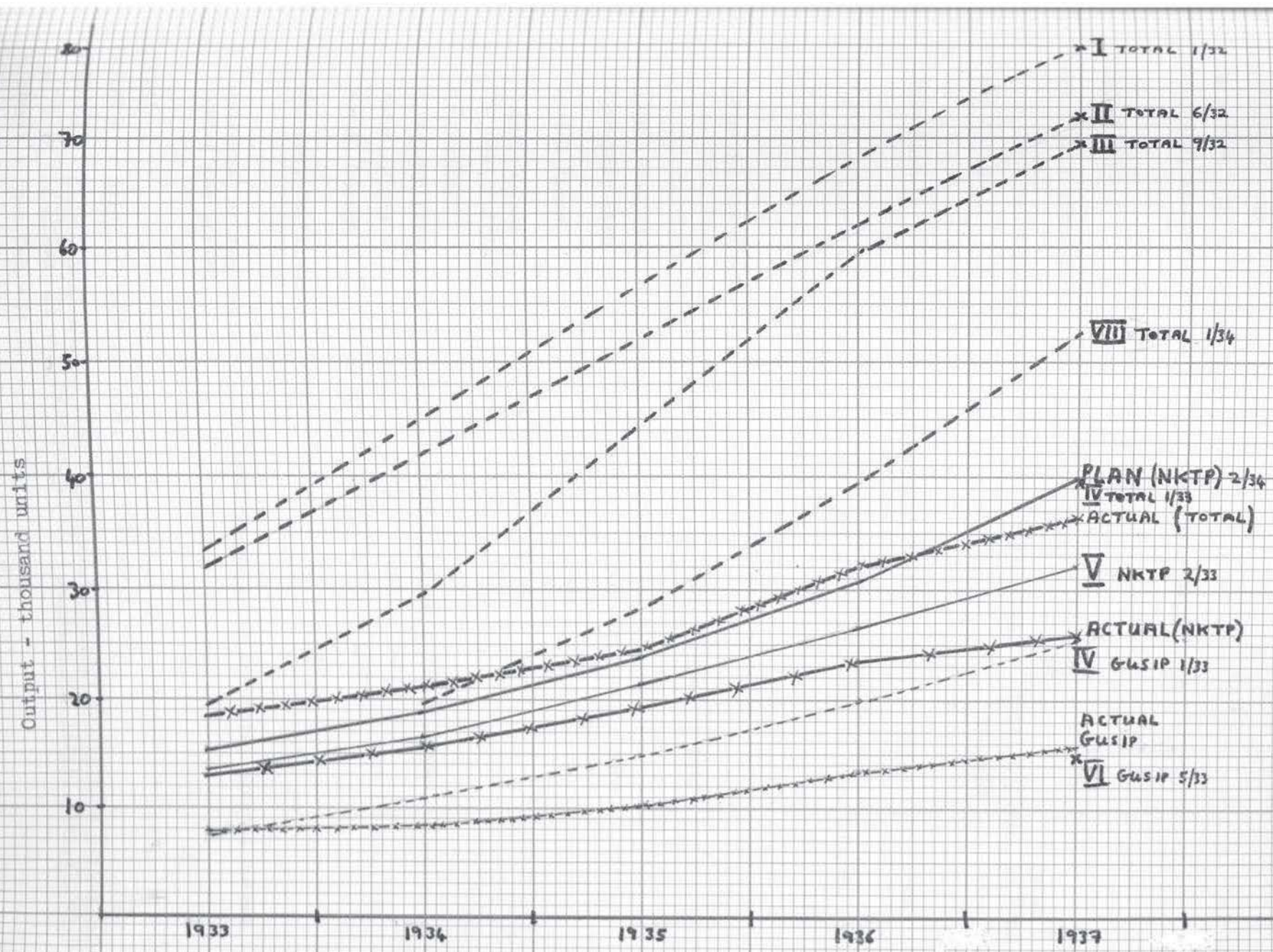
Variant VII : ZaInd., 30.12.33.

Variant VIII : SiI, 1934, No. 3, p. 1.

Variant IX : Proekt vtorogo pyatiletnego plana..., op cit, Vol. 1, pp. 69-70; 450-451.

Fulfilment: From Table SA.I.

Varianis of the Second Five-Year Plan for Machine Tool Building



The Third Five-year Plan, 1938-1942

Variant I

(May 1937 ; Al'perovich, on basis of Gosplan target)

Total output 1942 - 70,000 units.

GUSIP output 1942 - 38,000 units

Machine tool stock to double in the five year period.

Variant II

(March 1939 ; the final Third Five-year Plan)

	<u>1937 Actual</u>	<u>1942 Plan</u>	<u>Total 1938-42</u>	<u>Inc. % 1937-42</u>
Total output	36,120	70,000	270,000	194
inc.				
NKTyazhMash	19,330	43,000		222

Machine tool stock to increase from 380,000 units (1.1.38) to over 600,000 units.

Fulfilment of the Third Five-year Plan

	1938	1939	1940	1941	1942
1. Total (ex. simple mcs)					
Five-year Plan	(40000)	(46000)	(53000)	(61000)	70000
Annual Plans	n.a.	44415	51300	58000	
Actual Output	40170	40900	42500	n.a.	
Per cent fulfilment	100.4	88.9	80.2		
2. NKTyazhMash					
Five-year Plan	(25000)	(28000)	(32000)	(37000)	43000
Annual Plans	n.a.	27795	32000	35000	
Actual Output	n.a.	25030	27754	24572	
Per cent fulfilment	n.a.	89.4	86.7	/66.4/	

(..) estimated on the basis of the final year target and total planned output during the period.

Sources:

Variant I : ZaInd., 8.5.37; 10.5.37; SiI, 1938, No. 2, p. 3.

Variant II : Tretii pyatiletnii plan razvitiya narodnogo khozyaistva Soyuz SSR, 1938-1942 gg., M., 1939, pp. 20; 207.; XVIII s"ezd VKP(b), sten. otchet, p. 386.

Fulfilment : from Table SA.I.

THE STRUCTURE OF MACHINE TOOL INSTALLATIONS , 1918 - 1934

This section is devoted to an examination of the evidence on the structure of machine tools installed in Soviet industry, primarily the engineering sector, during the period 1918 to 1934 ; a period chosen because of the availability of detailed material provided by the 1932 census of metal working equipment (parts of which were updated to 1934 prior to publication in 1935). This analysis must necessarily be brief and cannot do justice to the wealth of material presented in the census, which represents a unique document, unrivalled by any subsequent published stock census for the USSR, and possibly any other country. The only major shortcoming of the census materials is that they exclude the specialised defence industry ¹. The following analysis is devoted to a consideration of such questions as the sectoral and branch structure of installations, the type of enterprise in which machines were installed, the role of imported equipment, the form of production organisation, the structure of types, the degree of specialisation and automation , and the labour skill requirements of the installed machines.

a. The Sectoral and Branch Structure of Installations

The structure of the entire civilian stock of metal cutting machine tools in the economy in April 1932 (the date of the census) is shown in the table (p.459). This reveals that 82 per cent of the stock was installed in industry, 11.7 per cent in transport and communications and less than three per cent in the agricultural sector. Of the total 60.5 per cent of machines were located in the machine building and ^{other} metal working branches (hereafter MCMW)². During the years 1917 to 1928 55 per cent of machines installed went to the MCMW branches; during the First Five-year Plan ³ these branches received over 64 per cent of all new installations.⁴ Of the total number of machines in the MC sector in April 1932 the largest sub-sector holding one quarter of the total was transport equipment and the second largest, agricultural equipment of all types. The largest individual

1. This is evident from the census materials themselves, but is confirmed by Kas'yanenko -Voprosy istorii, 1964, No.11, p.33.

2. For the purposes of the census machine building covered all branches making complete machines, whereas ^{other} metal working referred to branches devoted to the making of separate parts and assemblies, e.g. tools, bearings, fasteners, and diverse metal goods.

Table A3.I

The Distribution of Machine Tools by Branch of the Economy
10th April 1932

	<u>Number of metal- cutting mc.ts.</u>	<u>Per cent of total</u>
<u>1. Industry</u>		
Machine building	82,797	45.6
Other branches of metal working	26,948	14.9
Metal working enterprises not in use ²	2,338	1.3
Electrical battery and cable works	798	0.5
Specialised repair enterprises	3,496	1.9
Repair shops of industrial enterprises ³	31,612	17.4
Total Industry	<u>147,989</u>	<u>81.6</u>
<u>2. Transport and Communications</u>		
Locomotive and wagon repair shops(NKPS)	7,639	4.2
Workshops and depots of NKPS	8,500	4.7
Water transport repair works	3,135	1.7
Repair works of other transport orgns.	929	0.5
Repair works of communications	1,093	0.6
Total Transport and Communications	<u>21,296</u>	<u>11.7</u>
<u>3. Agriculture</u>		
Repair shops of MTS and Sovkhozy	4,794	3.4
<u>4. Municipal repair shops</u>	3,293	1.8
<u>5. Other branches</u>	4,031	2.2
Total Stock	<u>181,403</u>	<u>100.0</u>

1.Total number existing in the economy ,i.e. including machines not installed.

2.Machine tools at enterprises under construction.

3.Repair shops of machine building and other metal working enterprises included in the appropriate branches above.

Source:Sotsialisticheskoe stroitel'stvo SSSR,1935,p.70.

branch stock was in locomotive and wagon building (7,754 units), followed by agricultural machinery and implements (6,812) and the building of prime movers (diesels, internal combustion engines, etc.).

Turning to new machine tool installations, we find a very substantial change in the allocation by branches between the 1918 to 1928 period (for convenience here termed the restoration period), and the First Five-year Plan, taken here as 1929 to 1933.⁵

Table A3.II Branch Allocation of New Machine Tool Installations*

<u>Restoration Period (1918-28)</u>			<u>First Five-year Plan (1929-33)</u>		
Branch producing:	No. of units	Culmv. % total	Branch producing:	No. of units	Culmv. % total
1. Locomotives-wagons	1,652	10.1	1. Tractors	5,231	10.4
2. Electric power eq.	1,305	18.0	2. Automobiles	4,897	20.2
3. Agricultural mcy.	1,294	25.9	3. Agricultural mcy.	4,306	28.8
4. Control-measuring eq.	1,079	32.4	4. <u>Machine Tools</u>	4,087	36.9
5. Communications eq.	1,072	39.0	5. Electric power eq.	3,227	43.4
6. Prime movers	1,062	45.4	6. Locomotives-wagons	2,140	47.6
7. <u>Machine tools</u>	980	51.4	7. Prime movers	2,122	51.9
8. Fuel-ore eq.	949	57.2	8. Metallurgical eq.	2,102	56.1
9. Textile mcy.	734	61.6	9. Measuring-optical eq. ⁺	1,937	59.9
10. Clothing-footwear eq.	666	65.7	10. Auto-tractor spares	1,934	63.8
Remaining branches (20)	5,639	34.3	Remaining branches (20)	18,169	36.2
All branches	16,432	100.0	All branches	50,152	100.0

* Calculated from the time of installation of those machines in the stock in April 1932 (updated to 1933): therefore less accurate for restoration period in so far as some machines must have been withdrawn or relocated.

⁺ Items for individual use - clocks, watches, cameras, binoculars, etc.

Source: calculated from Oborudovanie, op cit, vyp. 2, pp. 130-133.

This reveals the massive increase in the rate of introduction of new machines during the First Five-year Plan, and the considerable role of new branches,

3. 'First Five-year Plan' here generally refers to 1929 to April 1932.

4. Calculated from Oborudovanie, op cit, vyp. 1, pp. 49-50.

5. If the end of 1932 is taken a number of major enterprises built during the First Plan period are excluded, including the Chelyabinsk tractor factory, the Khar'kov turbine factory, the Kramatorsk and Uralmashzavod heavy engineering works and the Gor'kii milling machine factory. Therefore, the end of 1933 is taken in order to allow for the longer gestation period of heavy engineering factories.

notably the auto-tractor industry accounting for one fifth of all installations. The prominent role of the machine tool industry itself is also notable. In both period only seven branches accounted for over half the total number of machines installed. Other, smaller branches which grew rapidly in the 1929-33 period include the making of office equipment, medical instruments, equipment for the food industry, and 'other' transport equipment (probably bicycles, and motor cycles).

b. The Role of Imported Machines¹

The census provides some information on the role of imported machines in the total stock and in installations of different periods, but the exclusion of the defence industry precludes a full assessment. The proportions of imported and domestically produced machines in the installations of different years were as follows:

The Share of Imported and Domestically Produced Machines Table A3.III

Year of installation*	All the Economy		Machine building and other metal working				
	Propn. of mc.ts (%) Imported	Produced in USSR	Propn. Imported %	Country of origin - per cent of all imported machines			
				Germany	USA	Britain	Other
Before 1917	75.7	24.3	82.3	42.6	32.0	11.7	13.7
1918 - 1928	68.5	31.5	73.7	55.0	21.6	8.1	15.3
1929 - 4/1932	57.6	42.4	63.9	54.0	29.5	7.5	9.0

* or year produced in few cases where year of installation unknown.

Source: calculated from Oborudovanie, op cit, vyp.1, pp.49-50.

Thus the share of imported machines gradually declined to the extent that over forty per cent of all installations in the First Five-year Plan were of domestically built products. Germany was the major foreign supplier, but the USA accounted for thirty percent of imports in the First Plan. As one would expect, the imported machines went predominantly to the MCNW sector but, nevertheless, over one quarter went to other sectors of the economy, a much lower proportion than during the restoration period. During the First Five-year Plan years the domestic industry met 55 per cent of the installations in 'other' sectors, compared with only 36

¹ See also Table SA.XXVI, pp.

per cent in the MCMW sector. The direction of installation of imported and Soviet-built machines is shown by the following table:

Table A3.IV

The Distribution of Imported and Soviet-built Machines by Sector of the Economy

Year of installation	Imported machine tools Per cent installed in:		Soviet-built machine tools Per cent installed in:	
	MCMW	Other	MCMW	Other
Before 1917	70.4	29.6	47.1	52.9
1918-1928	59.0	41.0	45.8	54.2
1929-4/1932	71.3	28.7	54.6	45.4

Source: Calculated from Oborudovanie, op cit, vyp.1, pp.49-50.

The branches with the highest share of imported equipment were either those which developed vigorously during the First Five-year Plan period, or those requiring special, heavy or large machines not then built in the USSR. In MC alone in April 1932 the average proportion of imported machines was 74.0 per cent; the highest shares were found in the automobile industry (92.8 per cent), the tractor industry (90.0 per cent), the production of measuring-optical equipment of personal use (86.1 per cent) and the electric power equipment industry (84.5 per cent). Two branches of heavy engineering also had a high degree of import dependence: the locomotives and wagons industry (80.6 per cent) and the metallurgical equipment branch (80.3 per cent). As one would expect the degree of reliance on imports depended to a great extent on the complexity of each particular type of machine: of the total stock in April 1932 in MCMW over 93 per cent of all gear cutting machines were of foreign origin, 91.5 per cent of turret lathes, automatics and semi-autos, 89 per cent of boring machines, 87 per cent of milling machines and 73.4 per cent of grinding machines, but only 57 per cent of threading machines, 61 per cent of drilling machines and 67 per cent of lathes.

c. Machine Tool Installations by Type of Enterprise

1. New and Old Enterprises

The following table indicates the age of enterprises in which machine tools were installed in various years for those machines in the stock of April 1932:

Table A3.V

Machine Tool Installations and the Year of Foundation of Enterprises
in Machine Building

Year of Foundation of Enterprise ¹	Year of Installation of Machine Tools			
	Before 1917	1918-1928	1929-Apr.1932	Total
Before 1917	26,504	13,911	18,007	58,422
1918-1928	212	1,887	3,492	5,591
1929-Apr.1932	588	468	12,790	13,864
Total	27,304	16,284	34,289	77,877

1. The presence of old machines at 'new' enterprises is explained by the fact that the pre-1917 group includes a number of enterprises evacuated from the Baltic republics during the War; the 1918-1928 group includes a number of new enterprises created by concentrating existing factories; and two fundamentally reconstructed enterprises (the Moscow AMO factory and the Putilov tractor department) were categorised as new enterprises of 1930.

Source: Calculated from Oborudovanie, op cit, vyp.2, p.168.

From this table it can be seen that of the total number of machines installed during the First Five-year Plan, 12,790, or 37.3 per cent, were installed at enterprises founded during the Plan period itself, while 52.5 per cent were used in the reconstruction and expansion of enterprises founded before the Revolution. Machine tools installed at enterprises founded during the Plan period represented 17.8 per cent of the total stock of April 1932, whereas those installed at enterprises founded before 1917 accounted for 75.6 per cent.

ii. The Scale of Enterprises

The census does not provide much information on the scale of enterprises, but the limited data presented do provide an interesting indication of the degree of concentration of the machine building industry in April 1932 and the relationship between scale and installations in different periods. From the table it can be seen that in the restoration period machines tended to be installed at small and medium sized enterprises: in fact 48 per cent of all 1918 - 1928 installations were at enterprises of 5 million rubles or less basic funds, but

only 6 per cent at the very largest enterprises of 50 million rubles basic funds. In the First Five-year Plan period these proportions were respectively 41 and 22.5 per cent, showing the importance of very large enterprises.

Table A3.VI

The Scale of Enterprises and the Age of Machine tools - Machine Building
Stock of April 1932

Scale of Enterprises Value of Basic Funds ('000 rubles)	Stock April 1932		Age structure of machines by scale group (per cent of total by scale group)			
	No. of units	% of total	Machines installed:			Yr. not known
			Before 1917	1918-28	1929-4/32	
Up to 250	1,940	2.4	10.6	21.9	58.4	9.1
251 - 500	3,189	4.1	14.2	32.5	47.4	5.9
501 - 1000	4,338	5.6	17.2	28.4	44.7	9.7
1001 - 2500	9,529	12.2	23.3	27.4	46.6	2.7
2501 - 5000	9,825	12.6	28.4	24.2	45.3	2.1
5001 - 10000	13,747	17.7	36.3	23.4	38.6	1.7
10001 - 25000	10,324	13.3	42.8	21.9	32.5	2.8
25001 - 50000	12,773	16.4	57.1	14.2	27.3	1.4
Over 50000	12,212	15.7	28.6	7.9	61.0	2.5
Total	77,877	100.0	33.9	20.4	42.5	3.2

Source: Calculated from Oborudovanie, op cit, vyp.2, p.218.

But despite the emphasis on extremely large enterprises in the First Five-year Plan period, larger enterprises tended to have a higher proportion of old machines than small and medium sized enterprises.

iii. Type of Production at Enterprises

Machine building enterprises were grouped in the census by the type of production organisation, defined not by the organisation of machine shops, but by the nature of the assembly of the final product. Three categories were distinguished: first, individual and small serial production, eg. 'Krasnyi Putilov' (with the exception of its tractor department), 'Elektrosila' and 'Krasnaya Presnya'; second, large serial production, e.g. the 'Samotochka' machine tool factory,

and the 'Krasnoe Sormovo' loco-wagon works; third, enterprises with mass-flow production, divided into two groups - first, those of a multi-product nature, e.g. the Rostov agricultural machinery factory, and second, those making only one or two products, e.g. the Stalingrad and Khar'kov tractor factories, the Moscow and Gor'kii automobile works, and the Moscow first and second watch factories.¹ Enterprises with mixed forms of production were categorised according to the form which was dominant - a procedure which probably led to an overstatement of the role of large serial and mass production.

A high proportion of installations during the First Five-year Plan years were at mass-flow type enterprises. The changing emphasis on different forms of production is shown by the following table:

Table A3.VII

Machine tool Installations in Machine Building according to the Type of Production of Enterprises

Type of Production	Proportion of installations by type of production (per cent)								
	Year of Installation:								Stock of April 1932
	Pre-1917	1918-27	1928	1929	1930	1931	1932	1933	
Individual & Small serial	38.4	27.4	28.4	24.6	21.2	18.0	31.3	27.1	28.3
Large serial	38.7	51.7	48.8	44.5	35.7	36.5	37.2	32.5	41.1
Mass-flow	22.9	20.9	22.8	30.9	43.1	45.5	31.5	40.4	30.6
(inc.1-2 items	11.6	9.1	9.0	12.8	25.5	37.1	20.5	31.9	18.5

Source: Calculated from Oborudovanie, op cit, vyp. 2, p. 193.

The very high proportion of mass-flow production indicated for 1930 to 1933 is clearly caused by the installation of machines at the auto-tractor factories (exclusion of the tractor branch alone reduces the share of mass-flow production in 1933 to 28 per cent). It is probable that the high share of mass-flow production indicated by the census for April 1932 was a temporary phenomenon stemming from the peculiarities of the branch structure of installations in the preceding three year period : after 1933 it is likely that the share of individual and small serial production increased.

1. Oborudivanie, op cit, vyp. 2, p. XIII

d. The Arrangement of Machine Tools

The traditional type of machine layout in the production shops of individual and small serial engineering factories is the grouping together of machines of a similar type or size. In large serial and mass production it becomes expedient to arrange machines according to the flow of work. The role of flow production and its definition are discussed in Appendix 6 .

The extent of the adoption of flow organisation during the First Five-year Plan period is indicated by the following table:

Table A3.VIII

The Arrangement of Machine Tools in the Production Shops of Machine Building Enterprises ¹

	Stock April 1932	Of the April 1932 stock - machines installed:			
		Before 1928	1928	1929-30	1931-4/1932
All installed machines	57,375	31,631	2,528	10,260	12,956
Arranged in Flow ²	11,878	3,948	306	2,544	5,080
Flow as per cent of total installed	20.7	12.5	12.1	24.8	39.2

1. Machining and assembly shops.

2. Remainder arranged in groups according to type or size, or in some other way.

Source: Oborudovanie, op cit, vyp. 4, p. 32.

During the First Five-year Plan period 32.8 per cent of all machines installed in production shops were arranged on a flow basis. These machines were predominantly installed at new enterprises built during the Plan period:

Table A3.IX

The Arrangement of Machine Tools according to the Year of Foundation of Machine building Enterprises

Year of Foundation of Enterprises	Stock of April 1932	Of the April 1932 stock - arranged by:		
		Flow %	Groups %	Other %
Before 1917	43,209	4,600 10.9	32,276 74.7	6,223 14.4
1918 - 1927	3,486	763 21.9	2,256 73.3	167 4.8
1928 - Apr. 1932	10,680	6,525 61.1	3,695 34.6	460 4.3
All Enterprises	57,375	11,888 20.7	38,227 67.3	6,850 12.0

Source: Oborudovanie, op cit, vyp. 4, p. 74.

From the above two tables it can be deduced that very few of the new machines installed during the First Five-year Plan were employed at old enterprises on a flow basis, and that a substantial number of older machines at existing enterprises must have been reorganised to provide a flow arrangement. As one would expect the majority of the machine tools arranged on a flow basis were to be found at enterprises of a mass-flow type.

There was undoubtedly a massive shift towards flow production at new enterprises built during the 1929 to 1932 period, but this shift was in the main accounted for by about five branches which developed intensively during these years.

Table A3.X

The Branch Concentration of Flow- arranged Machines in Machine Building

Branch Production of:	Stock in production shops (April 1932)		
	Flow-arranged mc.t.s		Per cent of all flow- arranged mcs.(cumulative)
	Number	% of stock	
1.Automobiles	2,783	79.8	24.8
2.Tractors	2,005	72.6	42.6
3.Agricultural mcy.	1,187	26.2	55.4
4.Electric power eq.	647	19.1	58.9
5.Machine tools	496	15.8	63.3
6.Locos,wagons	420	7.1	67.1
7.Measuring-optical eq.	296	17.1	69.7
Total seven branches	7,834	31.4	69.7
8.Clothing-footwear eq. ¹	1,875	58.9	86.4
Remaining 22 branches	1,530	5.4	100.0
All branches	11,239 ²	19.6 ²	100.0

- 1.This is an exceptional branch, the main enterprise of which, the Podol'sk sewing machine factory, was the sole mass-flow civilian engineering enterprise before 1914; its machines were arranged on a flow basis before the First Five-year Plan.
- 2.The total and percentage do not coincide with those usually given (11,883 and 20.7) - possibly because of an error in the source from which the branch data are calculated.

Source: Oborudovanie, op cit, vyp.4, pp.59-60.

Thus three branches which accounted for one-third of all new installations between January 1929 and April 1932 held 55 per cent of all flow-arranged machines at the time of the census. It is probable that the share of flow arranged machines

in the total stock declined by the end of 1933 with the commissioning of such large, heavy engineering works as Uralmashzavod, Kramatorsk, the Khar'kov turbine factory and the Lugansk locomotive factory.

e. The Structure of Types of Machine Tools

The 1932 census provides an extremely detailed analysis of the structure of the stock and new installations by type of machine. The structure of types installed in a given branch depends on many factors including the type of product, its weight and size, the scale of production, the type of production organisation, the skills of workers and the availability of machines of different types. In general, the more 'progressive' structure is that characterised by a relatively high proportion of automatic lathes and grinding machines and a relatively low proportion of lathes and planing and shaping machines. As a rule, the heavier the product the greater the reliance on lathes and planing machines; the branches making lighter products, especially those of interchangeable parts production, tend to have a much higher share of milling and grinding machines and turret lathes.

As one would expect, the structure of the machines installed outside the MCMW branches in the Soviet economy of 1932 was very different, and backward, compared with that of the MCMW sector: the machines installed were predominantly of a simple, general-purpose nature:

The Structure of the Stock by Main Sectors, April 1932. Table A3.XI

Sector	Share of total stock represented by: (per cent)											
	L.	PSS.	D.	T.	ASA.	M.	G.	GC.	B.	Br.	Th.	O.
MCMW	34.5	6.5	19.9	7.3	2.9	9.6	8.0	1.3	0.9	0.2	3.1	5.8
inc.MC	36.0	6.9	20.6	7.3	3.1	9.5	7.0	1.6	1.1	0.2	2.8	3.9
Rest of Economy	47.6	9.5	25.0	1.6	0.4	4.6	2.5	0.5	0.4	0.0	4.0	3.9
Total Stock	39.6	7.9	21.9	5.0	1.9	7.6	5.8	1.0	0.7	0.1	3.5	5.0

Key: L. - lathes; PSS.-Planing, shaping and slotting machines; D. -drilling machines; T. - turret lathes; ASA - automatics and semi-autos.; M. - milling machines; G. - grinding machines; GC - gear-cutting machines; B.- boring machines; Br. - broaching machines; Th. - threading machines; O. - other types.

Source: Oborudovanie, op cit, vyp.2, pp.2-5; Sotsialisticheskoe stroitel'stvo, 1935, p.74.

Machines installed in MCMW during the First Five-year Plan period had a markedly more progressive structure than those installed in the pre-1917 year and the preceding restoration period:

The Structure of Types in MCMW by Year of Installation Table A3.XII

Type of Machine	Structure of Types by year of Installation ¹ (per cent of total installed in each year)							
	Before 1917	1918-1927	1928	1929	1930	1931	1932	1933
Lathes	38.7	37.9	32.0	31.2	32.0	30.2	31.3	28.4
inc. centre, one tool	32.9	34.3	28.0	27.4	27.9	26.3	26.2	23.1
Turret lathes	6.6	9.2	7.0	7.6	6.1	6.6	5.2	5.9
Autos. & semi-autos.	2.0	2.6	2.3	2.8	4.2	3.7	4.0	5.9
Drilling mcs.	16.4	18.9	22.2	20.6	23.7	23.1	18.0	15.7
inc. vert. 1 spindle	11.4	15.6	17.1	16.9	19.0	16.6	12.7	9.2
" vert. multi-spindle	1.1	1.0	1.6	1.6	2.1	3.5	2.6	2.8
" radial drilling	2.7	1.7	2.3	1.7	1.5	1.8	2.8	2.2
Milling machines	10.6	8.6	9.3	9.5	7.9	9.8	10.3	10.8
Grinding machines	3.7	5.8	9.2	12.7	11.1	11.2	15.5	17.0
inc. tool grinding	0.9	1.2	1.4	1.3	1.7	1.9	2.5	2.1
Gear-cutting mcs.	0.8	1.1	1.2	1.1	1.8	2.2	1.2	2.0
Boring machines	1.3	0.7	0.9	0.7	0.5	0.8	1.1	1.8
Planing, shaping & slotting machines	8.2	7.2	6.3	5.6	5.3	5.3	5.5	4.8
Broaching machines	0.1	0.1	0.1	0.1	0.3	0.4	0.2	0.3
Threading machines	3.2	3.3	5.2	3.5	2.8	2.0	2.1	3.4
Other types	8.4	4.6	4.3	4.6	4.3	4.7	5.3	3.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1. Or year machine built in a few cases where year of installation unknown

Source: Obnovovanie, op cit, vyp. 2, pp. 20-22.

Thus during the 1929 to 1933 period, compared with the restoration period, the share of lathes and planing-type machines declined, turret lathes gave way to automatics and semi-autos, ordinary one-spindle drilling machines were replaced by multi-spindle models, and the share of grinding machines rose sharply. Also

notable is the extent to which the structure of types changed in the course of the First Five-year Plan: the share of grinding machines rose, while automatics and semi-autos played a greater role, their structure changing sharply - multi-spindle types represented only 10 per cent of all autos and semi-autos in 1929, rising to 55 per cent in 1933. In so far as the information relates to the stock of 1932, the structure of the installations of earlier years is influenced by the extent to which machines of different types survived. While no firm evidence is available it would seem likely that the more specialised and higher grade machines were kept in use in preference to simpler, more readily replaceable general-purpose machines and, if so, the improvement in the structure of installations must have been greater than indicated in the table.

Table A3.XIII

The Structure of Types and the Year of Foundation of Machine Building Enterprises

Type	Year of Foundation of Enterprises						Installations in 1929-32 at pre-1929 ents. ¹
	Pre-1917	1918-1927	1928	1929	1930-4/1932	All FYP1 1929-32	
Lathes	38.8	36.1	37.8	27.8	23.0	23.6	36.1
Turret lathes, autos & s-as.	9.8	15.7	15.7	7.4	11.5	11.0	10.2
Drilling mcs.	19.6	20.5	21.3	34.7	23.6	24.9	22.6
Milling mcs.	9.4	7.5	6.6	6.1	11.7	11.0	8.0
Grinding mcs.	5.7	6.2	4.8	8.5	13.9	13.3	7.8
Gear-cutting mcs.	1.0	1.5	0.1	0.5	4.3	3.9	1.4
Boring mcs.	1.3	0.3	0.4	0.5	0.7	0.7	0.9
Planing, shaping, slotting, and broaching mcs.	7.8	5.2	6.2	6.0	4.7	4.9	6.5
Threading mcs.	3.0	2.7	2.8	4.8	1.4	1.8	2.6
Other types	3.6	4.3	4.3	3.7	5.2	4.9	3.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1. Approximate - on the assumption that machines located at enterprises founded in 1929-32 were installed during the same period.

Source: Calculated from Oborudovanie, op cit, vyp.2, p.176 and p.30.

The considerable improvement of the structure of the stock which took place with the construction of new enterprises in the First Five-year Plan can clearly be seen from the above table. The share of lathes and machines of the planing group fell to a very low level, while that of grinding, milling and gear-cutting machines rose sharply. From the structure of new installations during 1929 to April 1932 and the structure of installations at new enterprises it can be estimated that the structure of types installed at older (pre-1929) enterprises was much less progressive than at the new, with a higher share of lathes and the planing group, and relatively fewer of the progressive types.

The table on the following page reveals a number of interesting features and determinants of the type structure in different branches. Branches are ordered according to the share of progressive types in their total stock in April 1932; in this case automatics, semi-autos, ordinary turret lathes, milling machines and grinding machines. A number of regularities are observable. The proportion of lathes and planing machines tends to vary inversely with the share of progressive types. Branches with a relatively high proportion of progressive types tend to be those having a large proportion of new installations during the First Five-year Plan period, while such branches also have a below average labour skill level.

The most striking feature of the type structures presented in the table is the very strong influence exerted by the type of product and the seriality of production. The first three branches, with an exceptionally high share of progressive equipment are ones producing light weight, relatively small, high precision products on a large serial or mass basis; the average skill level is extremely low and a high proportion of the stock of equipment is devoted to machining on a large batch or mass basis. A second group of eight branches can be identified covering those for which progressive machines represent 30 to 40 per cent of the stock, but also the exceptional agricultural machinery building branch which shares all the features of this group while having a lower proportion of progressive machines (because of the unusually large role played by drilling machines, representing one third of the stock, compared with the 15 to 25 per cent typical of other branches). This group is characterised by the large

Table A3.XIV

The Structure of the Stock of the Main Branches of the Engineering Industry
April 1932

Branch Production of:	Percent total branch stock ² I	II ²	Per cent installed FYP1 ³	Per cent machining batches of 500+	Average branch labour skill ⁴	Percent stock arranged in flow
1.Office Eq.	50.1	22.6	69.7	77.0	2.5	0.0
2.Clothing-f'wear eq	47.0	22.9	10.3	74.0	2.6	58.0
3.Measuring-opt.eq.	43.1	30.3	76.5	67.8	2.7	17.1
Average Group I	46.7	25.3	52.2	72.9	2.6	25.3
4.Tractors	39.8	25.1	85.4	35.9 ⁵	2.9	72.6
5.Automobiles	36.5	22.5	89.8	81.2	2.7	79.8
6.Machine tools	34.2	41.2	64.0	10.8	3.1	15.8
7.Auto-tr.spares	32.9	44.6	72.6	29.8	2.7	6.4
8.Control-measrg.eq.	32.7	41.7	44.9	41.9	3.0	3.6
9.Electric power eq.	31.1	36.3	43.7	17.5	2.9	19.1
10.Communications eq.	30.5	33.5	32.2	38.3	2.9	4.5
11.Agricultural mcy.	18.8	25.1	55.1	31.4	2.7	26.2
Average Group II	32.1	33.8	61.0	39.9	2.9	28.5
12.Textile mcy.	29.7	52.4	25.0	6.5	2.9	3.5
13.Other transpt.eq.	26.1	36.4	57.6	5.7	3.0	16.2
14.Pumps-compressors	24.0	53.7	30.8	11.5	3.2	4.5
15.Prime movers	22.5	53.9	18.2	4.4	3.2	5.3
Average Group III	25.6	49.1	32.9	7.0	3.1	7.4
16.Locos., wagons	20.1	52.3	16.1	8.3	3.5	7.1
17.Ships	18.5	51.5	20.3	5.0	3.8	3.6
18.Printing-paper eq	17.8	59.4	33.1	5.2	3.5	22.9
19.Fuel-ore eq.	17.6	56.5	40.0	4.5	3.6	5.9
20.Food inustry eq.	17.0	55.2	48.7	8.2	3.1	3.6
21.Timber ind.eq.	16.2	62.0	42.8	4.5	3.5	1.1
22.Metallurgical eq.	12.4	67.0	34.0	0.3	3.4	3.9
23.Lifting-trspt.eq.	12.3	55.9	43.4	5.9	3.1	11.2
24.Road-constrn.eq.	11.1	58.7	44.1	8.3	3.3	3.0
25.Boiler eq.	10.8	57.5	38.7	1.0	3.7	6.4
Average Group IV	15.4	57.6	36.1	5.1	3.5	6.9
All Branches ⁶	26.9	43.1	43.9	24.9	3.1	19.6

1.Total share of autos.,semi-autos.,turret lathes, milling machines and grinders.

2.Total share of ordinary lathes,planing,slotting and shaping machines.

3.Percentage of the stock of April 1932 installed 1929 to April 1932.

4.Average skill grade (on eight point scale)of machines installed in each branch.

5.Incomplete data - excludes the Khar'kov factory - branch average probably higher.

6.Including five branches of minor importance excluded from the table.

Source:Calculated from Oborudovanie,op cit,vyp.2,pp112-117 &130,vyp.4,pp65&68.

serial or mass production of medium or light products of a fairly high degree of precision. This group tends to have a high proportion of First Five-year Plan period installations, a relatively low average skill level, and quite a high proportion of machines devoted to machining in large batches. A third group of four branches represents medium machine building of a lower level of precision than group two; the labour skill level is somewhat higher and a much smaller share of installations date from the Plan period. Finally, there is a fourth group of branches having one fifth or less progressive machines, mainly devoted to the production of a range of medium-heavy to very heavy engineering products of relatively low precision, generally on an individual or small serial basis. This group tends to have ^a below average share of First Five-year Plan installations and a much higher than average skill level. As can be seen from the table, there is a close correlation between the proportion of machines arranged on a flow basis and the seriality of production. Flow-arranged machines had a very different structure of types than machines arranged on a group basis, as the following table shows:

Table A3.XV

The Structure of Types in the Production Shops of Machine Building Enterprises according to the Form of Machine Arrangement (April 1932)

Arrangement	Percentage of stock represented by:										
	L.	T.	ASA.	D.	M.	G.	GC.	P.	B.	Br.	O.
In Flow	16.9	5.9	3.9	34.8	15.6	8.9	3.3	2.6	0.9	1.2	6.0
In Groups of similar type or size	40.7	10.3	5.2	18.2	8.7	4.9	1.8	6.8	1.5	0.1	1.8

Key: as p. 468.

Source: Oborudovanie, op cit, vyp. 4, p. 102.

The characteristic features of the four groups are summarised by the indicated average (unweighted) values, which provide a basis for concluding that during the First Five-year Plan period new installations were primarily directed to light and medium engineering branches of a type suited to the employment of progressive equipment permitting the employment of workers of relatively low skills, the high level of seriality also allowing the adoption of the flow principle of organisation.

f. The Degree of Specialisation and Automation of Machine Tools

The machine tool census distinguished five degrees of specialisation of machines ranging from universal to narrowly special, with three intermediate stages¹. The degree of automation was defined according to a rather complex four point scale with a number of sub-divisions, but in essence the classification reduced to the following:

1. Machine tools without power feed: a. single tool ; b. multi-tool.
2. Machine tools with power feed: a. single tool ; b. multi-tool.
3. Semi-automatic machines (automatic control of feed, speed and the engagement of the tool(s)).
4. Automatic machines (as 3., plus automatic feed of material by magazine, bar feed device, etc.).

The largest single group of machines in the stock of April 1932 was that of universal machines of Stage I specialisation; during the First Five-year Plan the share of these machines in total installations in the engineering industry slightly declined, and the proportion of machines of Stage III rose:

The Specialisation of Machines in the Stock of the Engineering Industry
Table A3.XVI April 1932

Degree of Specialisation	No. of mc. ts.	Structure per cent	Structure of mcs. installed: before 1929	1929-4/1932
Universal: Stage I	28,720	36.2	37.9	34.1
Stage II	22,009	27.8	27.7	27.8
Stage III	24,258	30.6	28.9	32.8
Stage IV	1,121	1.4	1.3	1.5
Nrwlly. Spzd Stage V	3,189	4.0	4.2	3.8
All Machines	79,297	100.0	100.0	100.0

Source: Oborudovanie, op cit, vyp. 2, p. 107.

1. The degree of specialisation was defined in terms of the range of operations realisable on a given machine, and the range of types and sizes of components machinable without reducing its productivity.

Stage I - machines of the most universal type able to fulfil, within their technological function, all types of machining within a wide range of dimensional limits, and not requiring complex retooling on switching to work on parts of another type or size;

Stage II - Machines differing from stage I by one of the three listed features; i.e. a reduced ~~range~~^{scope} of machining, machinable dimensions, or requiring complex retooling on switching from one type of work to another;

Stage III - Differing from I by two of the listed features;

Stage IV - Machines of a reduced range of types of machining, a reduced range

Quite a large proportion of the universal machines installed during the First Five-year Plan were presumably used for equipping the toolrooms and repair shops of the new and expanded factories. If we consider the degree of specialisation according to the year of establishment of enterprises a greater shift towards more specialised equipment is revealed:

Table A3.XVII

The Specialisation of Machines in the Stock of Enterprises
Founded in Different Periods

Year of Foundation of Enterprises	Per cent of machines by enterprise age group: Degree of specialisation of machines in the April '32 stock				
	Stage I	Stage II	Stage III	Stage IV	Stage V
Before 1917	39.6	28.2	27.4	1.2	3.6
1918 - 1928	32.8	30.2	33.4	0.8	3.6
1929 - 4/1932	27.6	25.4	39.2	2.4	5.4

Source: Oborudovanie, op cit, vyp.2, p.179.

Thus the share of the more specialised types of machines (Stages III to V) rose from less than one third at enterprises founded before the Revolution to almost half at enterprises founded during the First Five-year Plan period.

Semi-automatic and automatic machines of all types represented 7.3 per cent of the total engineering stock in April 1932, while simpler machines without power feed represented 26 per cent. Machines installed during the First Five-year Plan period included a relatively higher share of the more automated types than those installed in earlier periods:

Table A3.XVIII

The Degree of Automation of Machines in the Stock of the Engineering
Industry, April 1932

Degree of Automation	No. of mc. t.s	Structure per cent	Structure of mcs. installed:	
			before 1929	1929-4/1932
Without power feed	21,253	26.0	26.3	26.0
With power feed- 1 tool	45,531	56.2	58.3	53.4
" " " - multi-tool	8,480	10.5	10.4	10.5
Semi-automatic	3,191	4.0	2.4	5.9
Automatic	2,653	3.3	2.6	4.2
All Machines	81,128	100.0	100.0	100.0

Source: Oborudovanie, vyp.2, p.103.

As with machine specialisation, the shift to more automated equipment was more marked than suggested by the above table: if account is taken of the year of foundation of enterprises, we see that machines installed at the new enterprises of the First Plan were characterised by a much higher level of automation than those installed at older factories, with a notably higher share of semi-automatic machines:

Table A3.XIX

The Degree of Automation of Machines in the Stock of Enterprises Founded in Different Periods

Year of Foundation of Enterprises	Per cent of machines by enterprise age group: Degree of automation of machines in the April 1932 stock				
	Without power feed	With power feed		Semi-auto	Automatic
		one tool	multi tool		
Before 1917	25.6	59.0	10.1	2.5	2.8
1918 - 1928	31.7	51.8	8.1	4.2	4.2
1929 - 4/1932	24.1	49.4	11.9	9.8	4.8

Source: Oborudovanie, op cit, vyp.2, p.179.

Most semi-automatic and automatic machines were of intermediate specialisation, predominantly Stage III, while the simpler machines without power feed tended to be of the somewhat lower degree of specialisation, Stage II.¹ The degree of specialisation of machines arranged on a flow basis tended to be much higher than for machines arranged in groups or on another basis.:

The Arrangement of Machines and the Degree of Specialisation Table A3.XX
(Production shops of engineering enterprises, April 1932)

Form of arrangement of machines	Proportion of machines by degree of specialisation(%):				
	Stage I	Stage II	Stage III	Stage IV	Stage V
In flow	16.6	26.4	39.7	2.4	14.8
In other arrangement	36.0	28.4	32.2	1.5	1.9

Source: Calculated from Oborudovanie, op cit, vyp.4, p.32.

cont. from p.474.

of machinable dimensions, and requiring complex retooling for different work; Stage V-Narrowly special machines designed specifically for performing a given automatically realised operation, or for making a specific part.

(see Oborudovanie, op cit, vyp.2, pp.XVI-XVII; Classification drawn up by Ya.Kvasha)

1. Oborudovanie, op cit, vyp.2, p.109.

The extent of utilisation of specialisation and automation of machines varies substantially from branch to branch, as the following table reveals. The branches are ordered and grouped according to the role of progressive types of equipment (p. 472 above).

Table A3.XXI

The Degree of Specialisation and Automation of Machine Tools Installed in Branches of the Engineering Industry, April 1932

Branch: Production Of:	Degree of Specialisation			Degree of Automation	
	Univl. Stage I	Intermediate Stage III	Speczd. Stages IV&V	Without power feed	Semi-auto and auto
1. Office equipment	24.7	46.2	2.0	47.5	4.3
2. Clothing-f'wear eq.	17.5	36.3	30.8	22.2	12.0
3. Measuring-optl.eq.	13.7	55.4	11.3	44.7	24.5
Average Group I	18.6	46.0	14.7	38.1	13.6
4. Tractors	27.3	45.1	7.6	13.1	18.9
5. Automobiles	27.0	38.3	11.6	20.9	16.5
6. Machine tools	39.4	30.5	3.5	21.6	7.3
7. Auto-tractor spares	37.3	36.5	3.3	25.3	11.2
8. Control-measrg.eq.	18.1	48.3	2.7	57.4	5.4
9. Electric power eq.	32.0	33.5	1.7	30.1	7.2
10. Communications eq.	18.0	42.2	2.5	53.4	7.5
11. Agricultural mcy.	37.3	20.5	3.5	30.3	3.0
Average Group II	34.6	36.9	4.5	31.5	9.6
12. Textile mcy.	41.8	35.3	1.6	20.8	4.6
13. Other transpt.eq.	37.1	29.0	3.0	30.5	7.7
14. Pumps-compressors	49.3	20.0	2.9	19.2	3.1
15. Prime movers	48.3	23.2	3.3	17.7	2.5
Average Group III	44.1	26.9	2.7	22.1	4.5
16. Locos., wagons	41.1	24.2	5.2	18.6	3.7
17. Ships	52.1	18.6	2.0	16.4	2.0
18. Printing and paper eq.	55.1	14.7	4.8	19.3	4.7
19. Fuel-ore eq.	53.8	19.4	2.4	16.4	3.8
20. Food Industry eq.	46.7	19.3	1.0	30.4	2.4
21. Timber industry eq.	55.6	12.5	0.4	17.8	0.6
22. Metallurgical eq.	57.3	16.4	4.6	9.4	4.7
23. Lifting-transpt.eq.	47.8	16.2	2.8	23.7	2.1
24. Road-constrn.eq.	50.3	16.4	2.3	24.3	1.9
25. Boiler eq.	48.6	14.7	1.4	21.7	1.0
Average Group IV	50.8	17.3	2.7	19.8	2.7
All Branches ¹	37.0	29.9	5.3	25.8	7.1

1. Including five branches of minor importance excluded from the table.

Source: Oborudovanie, op cit, vyp. 2, pp. 156-158.

From the above table it can be seen that narrowly specialised machines were used in quantity in only four branches; the clothing-footwear machinery branch dominated by the pre-War Singer factory was the only one to place considerable reliance on such machines. In general the light and medium engineering branches given priority during the First Five-year Plan period made considerable use of machines of intermediate specialisation, corresponding to the 'production' type equipment widely employed in the engineering industries of capitalist countries during the 1920s. In the branches of heavy engineering of low seriality medium engineering about half of the installed machines were of the widely universal type, with only one fifth of the stock taking the form of more specialised equipment of Stages III to V. The wide use of semi-automatic and automatic machines was again restricted to a small number of branches of light and medium engineering having a high seriality of production. Furthermore, those branches producing light products tended to make much greater use of relatively simple machines without power feed mechanisms. In the main mass production branches established during the First Plan period (the making of tractors, automobiles and their spares) a relatively high proportion of semi-automatic machines was installed; these three branches alone accounted for 40 per cent of all the semi-automatic machines installed in the engineering industry in April 1932, but one fifth of the automatics.¹

g. Labour Skills and the Machine Tool Stock

An interesting feature of the 1932 census was the attempt to determine the labour skill requirements of the machines in the stock in terms of the skills of the operators manning each machine at the time of the census, rated on the eight grade scale then employed. This information provided skill profiles of all branches and, in order to take account of possible divergences between the skills of workers and the skill requirements of the machines manned, account was also taken of the relationship between worker skills and the skill requirements of the work being performed on each machine on the day of the census. A striking feature of the First Five-year Plan period was the lowering of skill requirements in the engineering industry, notably at new enterprises founded within the Plan period itself. The skill levels at enterprises founded in different periods are

1. Oborudovanie, op cit, vyp. 2, pp. 156-158.

The extent of utilisation of specialisation and automation of machines varied substantially from branch to branch, as the following table reveals. The branches are ordered and grouped according to the role of progressive types of equipment (p. 472 above).

Table A3.XXI

The Degree of Specialisation and Automation of Machine Tools Installed in Branches of the Engineering Industry, April 1932

Branch: Production Of:	Degree of Specialisation			Degree of Automation	
	Univl. Stage I	Intermediate Stage III	Speczd. Stages IV&V	Without power feed	Semi-autos and autos
1. Office equipment	24.7	46.2	2.0	47.5	4.3
2. Clothing-f'wear eq.	17.5	36.3	30.8	22.2	12.0
3. Measuring-optl.eq.	13.7	55.4	11.3	44.7	24.5
Average Group I	18.6	46.0	14.7	38.1	13.6
4. Tractors	27.3	45.1	7.6	13.1	18.9
5. Automobiles	27.0	38.3	11.6	20.9	16.5
6. Machine tools	39.4	30.5	3.5	21.6	7.3
7. Auto-tractor spares	37.3	36.5	3.3	25.3	11.2
8. Control-measrg.eq.	18.1	48.3	2.7	57.4	5.4
9. Electric power eq.	32.0	33.5	1.7	30.1	7.2
10. Communications eq.	18.0	42.2	2.5	53.4	7.5
11. Agricultural mcy.	37.3	20.5	3.5	30.3	3.0
Average Group II	34.6	36.9	4.5	31.5	9.6
12. Textile mcy.	41.8	35.3	1.6	20.8	4.6
13. Other transpt.eq.	37.1	29.0	3.0	30.5	7.7
14. Pumps-compressors	49.3	20.0	2.9	19.2	3.1
15. Prime movers	48.3	23.2	3.3	17.7	2.5
Average Group III	44.1	26.9	2.7	22.1	4.5
16. Locos., wagons	41.1	24.2	5.2	18.6	3.7
17. Ships	52.1	18.6	2.0	16.4	2.0
18. Printing and paper eq.	55.1	14.7	4.8	19.3	4.7
19. Fuel-ore eq.	53.8	19.4	2.4	16.4	3.8
20. Food Industry eq.	46.7	19.3	1.0	30.4	2.4
21. Timber industry eq.	55.6	12.5	0.4	17.8	0.6
22. Metallurgical eq.	57.3	16.4	4.6	9.4	4.7
23. Lifting-transpt.eq.	47.8	16.2	2.8	23.7	2.1
24. Road-constrn.eq.	50.3	16.4	2.3	24.3	1.9
25. Boiler eq.	48.6	14.7	1.4	21.7	1.0
Average Group IV	50.8	17.3	2.7	19.8	2.7
All Branches ¹	37.0	29.9	5.3	25.8	7.1

1. Including five branches of minor importance excluded from the table.

shown in the following table:

Table A3.XXII

The Skill Levels of Machine Operators at Enterprises Founded in Different Periods (production shops, engineering industry, April 1932)

Year of Foundation of Enterprises	No. of mc. ts.	Average grade of operators	Proportion of machines in each group manned by operators of grades: (%)			
			I & II	III & IV	V & VI	VII & VIII
Before 1917	43,209	3.1	39.0	45.5	12.8	2.7
1918 - 1928	4,062	3.2	38.7	44.7	12.9	3.7
1929 - 4/1932	10,104	2.8	41.0	53.0	5.2	0.9
All Enterprises	57,375	3.1	39.4	46.8	11.4	2.4

Source: Oborudovanie, op cit, vyp. 4, p. 79.

Thus the new enterprises of the First Five-year Plan were founded on the semi-skilled worker, following the trend established in the West during the 1920s. The proportion of highly skilled workers of grades V to VIII was correspondingly very low, only 6 per cent against about 16 per cent for enterprises built before 1929. It is also notable that whereas at the enterprises founded before 1917 23 per cent of the machines were being manned by workers of a skill below that required by the job in hand on the day of the census, this was true of only 12 per cent of the machines at the newest enterprises. The deskilling process was clearly associated with the great emphasis placed on mass and large-serial medium and light engineering which characterised the 1929 to 1932 period. Analysis of the skill profiles of enterprises having different forms of production reveals large variations:

Table XXIII

Skill Levels of Machine Operators at Enterprises of Different Seriality of Production (production shops, engineering industry, April 1932)

Type of Production	No. of mc. ts.	Proportion of machines in each group manned by workers of grades: (per cent)				Av. Grade
		I & II	III & IV	V & VI	VII & VIII	
Individual & small serial	16,431	29.5	49.1	16.0	4.4	3.4
Large serial	23,327	39.3	46.7	11.9	2.1	3.1
Mass-flow	17,617	48.4	44.9	5.7	1.0	2.8
inc. 1-2 items	10,913	47.9	47.8	3.7	0.6	2.7
All Enterprises	57,375	39.4	46.8	11.4	2.4	3.1

Source: Oborudovanie, op cit, vyp. 4, p. 88.

The reduced skill requirements of the new enterprises were linked with the trend towards the use of machines of intermediate specialisation, Stages II and III, the next stage of specialisation, Stage IV, apparently gave no advantage in skill saving and this fact may account for their very limited employment. A considerable proportion, almost 30 per cent, of the universal Stage I machines were being manned by workers having a lower skill grade than that required by the work on the day of the census; this proportion fell as the degree of specialisation rose - 18 per cent for Stage II; 17 per cent for Stage III, and only 9 per cent for the narrowly specialised Stage V machines. The relationship between machine specialisation and labour skills is shown in the following table:

Degree of Specialisation of Machines and Labour Skills Table A3.XXIV
(Production shops, engineering industry, April 1932)

Degree of Specialisation	Proportion of machines manned by workers of grades: (per cent)				Average grade
	I & II	III & IV	V & VI	VII & VIII	
Universal - Stage I	29.4	50.1	16.4	4.1	3.4
Stage II	43.2	44.6	10.3	1.9	3.0
Stage III	44.1	46.2	8.3	1.4	2.9
Stage IV	36.9	52.2	7.1	3.8	3.1
Narrowly special. Stage V	58.3	36.0	4.5	1.2	2.7
All machines	39.4	46.8	11.4	2.4	3.1

Source: Oborudovanie, op cit, vyp. 4, p. 47.

The relationship between the degree of automation of machines and labour skills was more complex; the ordinary single tool machine with power feed required the highest average skill level, and the simple machine without power feed the lowest, even less than that required by semi-automatic and automatic machines. The machines without power feed were presumably very simple and used for performing highly differentiated machining operations. However, the semi-automatic and automatic machines were highly labour saving because unlike the simple machines they could be operated on a multiple-manning basis, i.e. one operator working on two or more machines at a time. Thus only 4 per cent of the ordinary single-tool machines were manned on this basis in April 1932, but a quarter of the semi-autos

(from two to five or more machines per worker) and half the automatics.¹ The relationship between the degree of automation and labour skills is shown in the following table:

The Degree of Automation of Machines and Labour Skills
(production shops, engineering industry, April 1932)

Table A3.XXV

Degree of Automation	Proportion of machines manned by workers of grades: (per cent)				Average Grade
	I & II	III & IV	V & VI	VII & VIII	
Without power feed:					
single tool	49.1	41.8	7.7	1.4	2.7
multi-tool	54.6	31.9	3.0	0.5	2.4
With power feed:					
single tool	33.5	48.6	14.5	3.4	3.3
multi-tool	45.2	45.1	8.5	1.2	2.9
Semi-automatic	27.9	61.7	7.7	2.7	3.2
Automatic	34.9	49.9	13.5	1.7	3.1
All machines	39.4	46.8	11.4	2.4	3.1

Source: Oborudovanie, op cit, vyp.4, p.50.

The average skill grade of workers manning individual types of machines was provided in the census, giving a useful indication of the implications of different structures of types of machines for the skill requirements of various branches:

Labour Skills and Individual Types of Machine Tools
(machines in production shops, engineering, April 1932)

Table A3.XXVI

	Average Grade	Percent mcs.manned by workers grades IV - VIII
<u>1.Very low skill types</u>		
Ordinary turret lathes	2.4	7.4
Multi-spindle drilling mcs.	2.4	8.2
Threading machines	2.5	8.7
Single-spindle drilling mcs.	2.6	12.9

1. Oborudovanie, op cit, vyp.4, p.50.

	Average Grade	Percent mcs.manned by workers grades IV - VIII
Broaching machines	2.7	7.0
Horizontal milling machines	2.7	15.5
<u>2. Average skill types</u>		
Surface grinding mcs.(vertical)	2.8	14.9
Single-spindle automatics	2.8	17.1
Multi -spindle autotmatics	2.9	15.7
Milling group (all)	2.9	23.7
Plano-milling machines	3.0	21.4
Multi-tool lathes	3.1	24.2
Vertical milling machines	3.3	36.9
Shaping machines	3.3	36.9
<u>3. High skill types</u>		
Centre lathes - one tool	3.4	38.7
Radial drilling machines	3.4	42.6
Grinding machines (all)	3.4	42.8
Gear-cutting machines	3.5	36.0
Universal milling machines	3.5	41.7
Cylindrical grinding mcs.	3.5	45.5
Slotting machines	3.5	47.6
Vertical turning and boring mcs.	3.6	49.6
<u>4. Very high skill types</u>		
Tool and cutter grinding machines	3.8	58.9
Planing machines	4.1	52.3
Boring machines	4.2	61.6
Wheel lathes	4.3	79.5
Combined machines	4.9	75.0
Average - all machines	3.1	28.8

Source: Oborudovanie, op cit, vyp.4, pp.109-110.

The average skill levels of different branches are shown above (p.472). The lowest skill branches were those possessing a high proportion of progressive types of intermediate and high specialisation, and an above average share of simpler, non-power feed models and also semi-automatics and automatics. The branches which developed most vigorously during the First Five-year Plan period tended to be those characterised by a low or very low average skill level, usually of a large-serial or mass nature.

A COMPARISON OF THE SOVIET AND AMERICAN MACHINE TOOL STOCKS

There are major difficulties involved in comparing the structures of the machine tool stocks of different countries. In the case of the Soviet and American stocks of the 1930s six main problems can be identified; three relating to the nature of the data available, and three of a more general methodological character.

1. The 'American Machinist' inventory, the only census available for the USA, was compiled on a sample basis and was therefore less comprehensive than the Soviet 1932 census which covered all enterprises;
2. The classifications of branches of industry were quite different, the Soviet census employing a much clearer and more rigorous system of classification, which included a distinction between the building of complete machines (machine building) and the production of machine parts and semi-fabricates (other metal working);
3. The definition of machine types and categories varied and lack of information about the definitions employed in both cases makes accurate comparison impossible;
4. For an accurate comparison adjustment is needed to take account of the different branch structures of the engineering industries of both countries;
5. Any comparison of the Soviet and American stocks is rendered difficult by the different levels of sub-contracting and provision of centralised services such as repairs, tool and fixture supply, etc. In the case of the Soviet industry a wider range of activities took place at the level of the enterprise, leading to a different, generally less progressive, stock structure.
6. One of the main determinants of the structure of machine tools in the stock is the scale of production of enterprises; as a rule the greater the scale of output of homogeneous products of a given type the more progressive the stock structure. There is insufficient information on the comparative scale of engineering enterprises in different branches in the Soviet Union and USA in the 1930s to determine the influence of this factor.

Despite these formidable problems the American stock structure does provide a very approximate yardstick against which changes in the Soviet stock can be

assessed, and the results are of interest in so far as the technology of the American engineering industry was considered worthy of emulation by Soviet industry. Furthermore, if any major differences are revealed they may pinpoint aspects of the practice of Soviet machine tool choice deserving attention as they may reflect responses to specific economic or technical circumstances of the period in question, or more general systemic differences.

From the point of view of comparability the American census of 1935¹ is the most appropriate in so far as it includes installations made during the 1929 to 1932 period covered by the Soviet census and, furthermore, the branch and type classifications employed are closer to those of the Soviet census than those employed in the 1930 American inventory². The classification of types adopted by the Soviet 1932 census has been taken as most suitable for comparative purposes and the American data adjusted accordingly.³

The main findings are shown in the tables, which provide a comparison between the Soviet and American stocks in the metal working industry as a whole and in machine building alone; in both cases an attempt has been made to adjust for differences of branch structures.

1. Supplement to American Machinist, European edition, 25.5.1935.

2. The overall stock structures revealed by the 1930 and 1935 American censuses were, in fact, very similar, the only differences of note being small declines in the shares of grinding machines and lathes, and small increases in the shares of boring and gear-cutting machines.

3. The following adjustments have been made to the American categories:

- a. vertical boring machines removed from 'boring machines' and added to lathes;
- b. broaching machines grouped with planing, shaping and slotting machines for most purposes;
- c. centering machines removed from 'drilling machines' and added to 'other' group.
- d. honing, lapping and cutting-off machines generally included in 'other' group unless specifically shown separately;
- e. 'floor grinders' excluded from 'grinding machines'. Note, the grinding machine groups in both censuses are the most difficult to reconcile, the American category apparently including a wider range of machines. The category 'floor grinder' cannot be reconciled with any of the types included in the Soviet census, but it is possible that other types shown in the American census were also excluded, e.g. 'disc' type machines.
- f. all metal forming machines have been removed from the American stock, and also polishing, buffing, pipe cutting and threading machines, shears, and 'other' machines.

In the case of the Soviet categories the only adjustment made when considering the metal working industry as a whole is the exclusion of the 'wood screw making machines' group (for machine building only their share is so small that they have been retained and included in 'other' machines).

Table A4.I

Comparison of the Soviet and American Machine Tool Stocks - all Machine
Building and Metal Working
(per cent total stock)

Type	USA				USSR		
	Stock of 1935		Adjusted stock ¹		Stock 1/1934 All	Mc.ts. installed:	
	All	Under 10 yrs. old	All	Under 10 yrs. old		1/29 - 12/33	at ents. founded 1/29-4/32
Lathes	20.3	15.5	22.0	16.9	34.8	30.8	25.4
Turret lathes	6.0	5.8	5.9	6.0	6.7	6.2	} 10.1
Autos & s-as.	5.1	7.2	3.9	5.6	3.3	4.2	
Drilling mcs.	21.0	23.3	20.0	20.8	19.7	20.6	23.6
Milling mcs.	11.3	9.8	10.5	9.4	10.0	9.8	10.7
Grinding mcs.	15.3	18.6	15.1	19.4	9.6	13.5	14.5
Gear-cutting m.	3.7	4.3	3.4	4.3	1.4	1.7	3.0
Boring mcs.	1.7	1.9	2.0	2.4	0.9	1.0	0.6
Planing mcs.	2.5	1.1	3.1	1.4	2.1	1.5	} 5.0
Shaping mcs.	3.2	2.6	3.7	3.2	3.4	2.9	
Slotting mcs.	0.7	0.5	0.8	0.6	1.1	0.6	
Broaching mcs.	0.6	0.6	0.5	0.4	0.2	0.3	
Threading mcs.	2.1	2.8	2.8	2.9	3.0	2.6	1.9
Cutting-off m.	4.9	5.0	5.5	5.8	2.0	1.9	} 5.2
Other mcs.	1.6	1.0	0.8	0.9	1.8	2.4	
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1. Adjusted very approximately for the main structural differences by removing two branches from the American stock (the aircraft industry and the production of domestic appliances) which do not appear in the Soviet data, and reducing the American motor industry stock by four fifths to bring its share in the total stock to that of the USSR in 1932.

2. New enterprises founded in the period January 1929 to April 1932, plus a number of radically reconstructed factories, notably the Moscow AMO vehicle factory. Data refer to the stock at these enterprises in April 1932.

Source:

USA - calculated from American machinist, European edition, supplement, 25.5.1935.

USSR - Stock of Jan. 1934 - Sotsialisticheskoe stroitel'stvo, 1935, pp. 82-83.

Installations, 1929 - 1933 - calculated from @borudovanie, op cit, vyp. 2, pp. 20-22.

Factories founded 1929 - 32 - calculated, ibid., pp. 176-177.

Table A4.II

Comparison of the Soviet and American Machine Tool Stocks - Machine Building

	Comparable Branches ¹			USSR All Machine Building, 4/1932			
	USA stock 1935		USSR stock 4/1932	All stock 4/1932	mc.ts instld. 1929-32	mcs.at ents.fd. 1929-32	mcs.at ents.of mass prdr
	All	under 10 yrs. old					
Lathes	20.5	15.8	37.5	36.0	31.1	23.6	23.7
Turret lathes	6.6	7.0	9.1	7.3	10.5	11.0	6.5
Autos & s-as.	4.4	5.5		3.1			6.4
Drilling mcs.	22.5	21.8	21.0	20.6	23.5	24.9	24.9
Milling mcs.	11.0	10.8	8.8	9.5	9.2	11.0	12.0
Grinding mcs.	14.0	16.5	6.3	7.0	10.0	13.3	10.0
Gear-cutting m.	3.2	3.6	1.3	1.6	2.4	3.8	2.9
Boring mcs.	2.2	2.6	1.3	1.1	0.8	0.7	0.6
Planing group ²	7.9	7.0	8.2	7.1	5.9	4.9	4.7
Threading mcs.	2.6	3.5	2.8	2.8	2.3	1.8	2.9
Other mcs.	5.1	5.9	3.7	3.9	4.3	5.0	5.4
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1. Twelve branches of the American stock having reasonably comparable equivalents in the Soviet census (fifteen branches according to the Soviet classification). These branches (the production of automobiles, agricultural machinery, rail equipment of all types, machine tools, prime movers, electric power equipment, construction industry equipment, fuel-ore industry equipment, food industry equipment, lifting and transport machinery, office machinery, pumps and compressors, printing and paper machinery, and textile machinery) account for 47 per cent of the Soviet MCMW stock of 1932 and 56 per cent of the USA stock of 1935. Differences in branch structure have been eliminated by adjusting the American branch structure using branch weights derived from the Soviet stock of April 1932.

2. Planing, shaping, slotting and broaching machines.

Source:

USA - calculated from American machinist, European edition, supplement, 25.5.1935.

USSR - comparable branches - calculated from Oborudovanie, op cit, vyp. 2, pp. 112-117
 all machine building - Sotsialisticheskoe stroitel'stvo, 1935, p. 74.
 machines installed 1929 to April 1932 - Oborudovanie, vyp. 2, p. 30.
 machines at enterprises founded 1929 to April 1932 - ibid., pp. 176-177.
 machines at enterprises with mass-flow production - Sotsialisticheskoe stroitel'stvo, 1935, pp. 84-85.

From Table A4.I it can be seen that there were a number of quite substantial differences between the American 1935 stock and that of the USSR in January 1934. The main differences were of the type one would expect - a higher share of the less progressive types, notably ordinary lathes, slotting and threading machines, and a lower share of progressive types such as automatics and semi-autos, grinding machines, gear-cutting machines and broaching machines. The lower proportion of automatics was compensated by a relatively higher share of ordinary turret lathes. But, if account is taken of the more recently installed Soviet machines a rather different picture emerges: in the years of the First Five-year Plan the Soviet stock converged rapidly to the overall structure of the American stock, although it still lagged from the structure of American machines installed in the 1925-35 period. This convergence is especially striking at new enterprises founded in the Plan period; the share of ordinary lathes is in this case close to the American (adjusted) proportion, and the most significant discrepancy is a much lower share of boring machines. A similar pattern emerges for the machine building branches alone. Comparison of comparable branches reveals a quite considerable difference between the Soviet 1932 stock structure and that of the USA in 1935, a difference which is even more marked if only the younger American machines are considered. The younger Soviet machines are, however, much closer in structure to those of the USA, especially at new enterprises, this shift being closely linked with a transition to a higher level of seriality of production: the stock of machines at Soviet mass-flow production enterprises was not very dissimilar in structure from the American 1935 stock. Thus, in the First Five-year Plan Soviet industry made considerable progress in modernising the structure of its machine tool stock in a direction similar to that taken by the American metal working industry.

The main consistent differences between the Soviet and American stocks will now be examined in detail. They can be summarised as follows:

- a. a notably higher proportion of ordinary lathes;
- b. a somewhat lower proportion of automatic and semi-automatic lathes, but a correspondingly higher proportion of non-automatic, turret lathes;

- c.a consistently lower proportion of grinding machines;
- d.a rather lower share of gear-cutting machines (not so marked at new enterprises);
- e.a consistently lower share of boring machines;
- f.a slightly smaller proportion of planing machines;
- g.a smaller proportion of broaching machines;
- h.a consistently smaller share of cutting-off machines.

The most significant of these differences are a.,c.,e. and h. ; differences which are to some extent interrelated in so far as the lower share of grinding machines, boring and cutting-off machines was compensated by the higher share of ordinary lathes.

The relatively high proportion of lathes and low proportion of grinding machines can be explained above all, we believe, by the nature of the material input. In the case of the American engineering industry this input took the form of high-quality, accurate forgings, stampings and castings, and rolled metal of a wide range of profiles. The accuracy of the semi-fabricates meant that rough machining of the type generally performed on an ordinary lathe was reduced to a minimum and many parts could be directly machined on grinding type equipment, by-passing the traditional metal-cutting machines. In the Soviet Union of the 1930s (and also today) the main input of semi-fabricates took the form of castings, a relatively small share falling to stampings and forgings, while rolled metal was produced in a very limited range of profiles. Furthermore, the quality of castings tended to be lower than in the USA, the spoilage rate being very high, and the castings had much greater allowances, the extra metal having to be removed by rough machining operations, primarily on ordinary lathes. Excessive and variable allowances were a persistent problem of the period caused partly by shortcomings of foundry technology, and partly by the system of plan indicators which assessed the performance of foundries in terms of weight. The narrow range of profiles of rolled metal, in part stemming from excessive specialisation of rolling mills during the Second Five-year Plan period¹, meant that much extra rough machining was required on many items produced from rolled metal stock.

1. See Granovskii, E.L. and Markus, B., Ekonomika sotsialisticheskoi promyshlennosti, M., 1940, pp. 257 and 265.

The poor quality of the castings and forgings of the period not only led to an increase in the role of lathes, but generally inhibited the use of progressive technology. Examples of this negative influence can be found in the machine tool industry itself. At the 'Krasnyi Proletarii' factory when the 'DIP' lathe was being assimilated it was found that progressive methods of machining and special fixtures originally selected had to be rejected or adapted in view of the 'extraordinary' variation in allowances on castings (from 5 to 15 mm). This variation made it impossible to correctly locate components in fixtures, e.g. for surfaces of a housing for gearboxes it was intended to use a roughing grinder, but this had to be rejected in favour of a milling machine.¹ The inferior quality of castings and forgings also imposed constraints on Soviet engineers buying progressive equipment in the United States.²

While the poor quality of the semi-fabricates was probably the primary reason for the hypertrophy of the stock of lathes and the relatively small grinding machine stock compared with the USA, an additional factor influencing the role of grinders was certainly the lower quality demands of the Soviet engineering industry of the period. The quality of Soviet finish was not a primary concern except where necessary for technical reasons and this bias was reinforced by the product structure which was orientated predominantly to the industrial or other productive consumer, rather than the individual final customer. Furthermore very few machines had to meet more rigorous demands of export markets.

In considering the share of grinding machines in the Soviet stock, and also other progressive types, one cannot ignore the question of supply. The domestic production of grinding machines, one of the most difficult types of machine tool to build because high standards of precision are required, was not properly organised until the Second Five-year Plan. During the years of the First Plan almost all grinding machines were imported so that while the new, high-priority enterprises were probably quite well supplied, but other lower-priority branches and enterprises probably had to find substitutes for grinding machines and other progressive types. During the Second and Third Five-year Plans the limited domestic production almost certainly went predominantly to priority branches, notably the

1. SiI, 1933, No. 10, p. 9.

aircraft industry, Import possibilities at this time were even more limited than during the First Five-year Plan, so the lathe-grinding machine imbalance was probably maintained, or even reinforced, in many branches of the Soviet engineering industry during the 1930s.

An additional factor leading to an inflation of the lathe stock was the fact that a relatively small place was occupied by specialised cutting-off machines (metal disc saws, band saws, abrasive disc cutters, etc.). Cutting-off operations had to be performed on general-purpose machines. This bias can be explained firstly by a desire to avoid special equipment which may not have been fully utilised, and secondly by supply considerations: metal cutting disc saws were not built in the USSR until the Second Five-year Plan and it is unlikely that foreign exchange was allocated for their importation in view of the ready availability of substitutes.

The relatively smaller share of gear-cutting machines can probably be explained by structural differences - with the development of the motor industry and machine tool building during the First Five-year Plan the proportion rose sharply, notably at new enterprises. The case of boring machines is different, however, and a combination of two factors probably accounted for their low share. First, boring machines tended to have a very high initial cost compared with other general-purpose machines³ and, second, boring machines posed very high skill demands⁴. Thus the low proportion of boring machines can probably be explained in terms of capital saving, adjustment to the scarcity of skilled labour or, more plausibly, a combination of both factors. The same probably applied to planing machines. The relatively lower proportion of automatics and semi-autos could have been a result of a number of factors: differences in the scale of production and the seriality of output, the high initial cost of the machines - most of which were imported until the mid-1930s, and the fact that high skills were required for setting up the machines and their maintenance.

2. This fact is noted by a former chief engineer of the GAZ factory - Bylii industrial'nyi, M., 1970, p. 82.

3. The average unit value of boring machines in the April 1932 stock was 12,500 rubles compared with 2,630 rubles for single-tool lathes and 1,117 rubles for vertical single-spindle drilling machines - Oborudovanie, op cit, vyp. 1, pp. 2-5.

4. See Appendix 3, p. 482.

The main differences between the Soviet and American stocks were not simply features of the development of the pre-War period, but have persisted to the present day. Comparison of the Soviet and American stocks of 1962 and 1965 respectively reveals the same larger share of lathes, and smaller shares of grinding and cutting off machines, while the slight difference in emphasis on turret and automatic and semi-automatic lathes remains. Pal'terovich, in presenting this comparison, also stresses the determining influence of the structure and quality of semi-fabricates, coupled with somewhat lower quality standards for the finish of engineering products.¹

The comparisons so far have been of a global type, but it is also of interest to examine two individual branches of great importance: the motor industry, the choice procedures of which have been considered, and the machine tool industry itself. It must be noted that the scale of the Soviet vehicle factories, AMO and GAZ, while very large by European standards was not as great as that of major American light car enterprises, and also that the Soviet factories were primarily devoted to the building of trucks, and activity which requires somewhat heavier and larger machines and lower quality demands for surface finish. In the case of the Soviet motor industry stock there is a possibility of providing an indication of the influence of adjusting the stock for differences in the extent of in-plant repair, worker training and toolmaking activities, on the assumption that most of these activities were organised as separate basis in the USA. Data are available for the structure of equipment in the machining and assembly shops only, and for the whole stock, for branches of engineering characterised by the mass-flow production of one or two items: the automobile industry was a major component of this group.² Applying the proportions obtained in this way to the motor industry, it is possible to calculate (very approximately) the structure of the stock of the main machining and assembly shops. The results are shown in the table. Again, the the most significant difference is the lower share of grinding machines in the Soviet stock, compensated in part by a slightly higher share of milling machines. In this case the nature of the product is probably the main determinant. The scale factor probably accounts for the rather lower proportion of automatics and

semi-autos. This analysis suggests that the Soviet automobile industry adopted the latest technology of the American industry almost without any adaptation.

Table A4.III

The Structure of the Machine Tool Stocks of the Soviet and American Automobile Industries

	L.	T.	A.	D.	M.	G.	GC.	B.	PSS	Br.	T.	O.
USSR 4/1932	17.8	—	11.0	28.1	11.6	13.9	4.2	0.6	—	4.7	1.1	7.0
" " prodn.shops*	13.9	—	14.1	31.3	13.4	10.8	5.5	0.7	—	2.5	1.3	5.5
USA 1935	14.4	6.6	10.0	25.5	10.9	16.5	5.4	0.6	1.9	0.9	3.3	4.0
USA 1935 mc.ts. under 10 yrs.old	11.9	4.9	12.1	29.5	10.6	16.5	4.6	0.5	1.6	1.0	2.8	4.0

*Approximate

Key - L.- lathes; A. -automatics and semi-autos; D.- drilling machines; M. - milling machines ; G. - grinding machines; GC- gear-cutting machines; B.- boring machines; PSS- planing, shaping and slotting machines; Br. - broaching machines; T. - threading machines; O. - other types.

Source:

USA - calculated from 1935 Inventory, op cit.

USSR - Oborudovanie, op cit, vyp.2, pp.112-117.

If account could be taken of the scale factor it is quite possible that Sorokin's assertion in 1933 would be proved correct: "In general, by type and productivity of their equipment our automobile factories are undoubtedly at a higher level than American factories of a similar scale".³ This finding is in line with that of Dodge for the tractor industry - American production technology was used without adaptation.⁴ The significant feature of both these new branches created in the First Five-year Plan period was that they were granted first priority and were equipped almost entirely with foreign machinery; it seems reasonable to assume that such a pure 'American' solution was not adopted in lower priority branches forced to rely to a greater extent on domestically produced equipment.

1. Pal'terovich, D.M., Planirovanie potrebnosti v oborudovanii, M., 1972, p.127.

2. Oborudovanie, op cit., vyp.2, pp.184-185; 191-192.

3. ZaInd., 17.1.33. See also the comment by an American observer, W.Carver, cited above, p.

4. Dodge, N., Trends in labour productivity in the Soviet tractor industry, Harvard, 1960, Unpublished PhD thesis, pp.415-416.

The machine tool industry presents a rather different case in so far as it was less reliant on foreign equipment, and machine tool building is generally regarded as one of the most highly skilled branches of engineering. In view of the high average scale of Soviet machine tool enterprises and the long production runs one would expect a relatively progressive stock compared with the American industry; but against this must be set the lower level of parts specialisation and greater role of in-plant toolmaking, repair and training facilities. The machine tool industry is the only Soviet branch for which information on the stock at the end of the period is available. ~~It should be noted that the April 1932 stock data do not include the new Gex'kii and Ia. Ordzhonikidze works.~~

Table A4.IV

The Structure of the Machine Tools Stocks of the Soviet and American
Machine Tool Industries

	L.	TA.	D.	M.	G.	GC.	B.	PSSB.	T.	O.
USSR 4/1932	33.5	14.6	16.1	11.3	8.3	1.8	1.4	7.7	1.4	3.8
USSR 1940	22.0	16.2	10.9	11.0	9.8	6.5	.	.	.	.
USA 1935	19.5	9.7	12.0	18.3	19.5	4.4	2.7	6.9	2.6	4.0
USA mc.t.s under 10 yrs. old	18.5	11.3	9.9	16.2	24.9	4.9	3.8	4.3	2.2	4.0

. no data

Key - as p.492 except TA. - turret lathes, automatics and semi-autos; PSSB. - planing shaping, slotting and broaching machines.

Source:

USSR - 1932 - Oborudovanie, op cit., vyp.2, pp.112-117.

1940 - Omarovskii, op cit., p.67.

USA - calculated from 1935 Inventory, op cit.

The difference in the share of grinding machines is very marked in this case, and there is also a significant divergence in the use of milling machines. The relatively high proportion of turret lathes and automatics in the Soviet stock may in part reflect scale differences, but also the fact that many fasteners were made by the factories themselves. Again, the high proportion of gear-cutting machines in 1940 probably reflects the fact that gears were not supplied on a sub-contract basis. It is known that processes in the machine tool industry were adapted to

take account of the lack of skilled workers, especially during the First Five-year Plan period. At the 'Krasnyi Proletarii' factory, for example, at the time of assimilating the 'DIP' lathe, hand scraping of surfaces had to be carried out because the technology of surface grinding had not been mastered (a case of the adoption of labour intensive methods not for reasons of capital saving, but because skills were lacking)¹. At this factory the share of grinding machines in the stock rose from 4-5 per cent in 1934 to 10 per cent by 1939, and in 1938 all machine tool beds were finished on surface grinding machines without further hand work, indicating that the technology of grinding had by then been mastered.² Planing of beds was substituted for the more progressive milling because of the poor quality of castings, but special templates had to be used in order to reduce the skill required. Boring machine operations had to be deskilled by provision of elaborate special fixtures and, in fact, fixtures had to be made in order to deskill many components produced on a range of machines.³ Thus, in the case of the machine tool industry, and presumably also other branches of engineering making products of a high technical level, capital had to be substituted for scarce labour skills.

It has been argued elsewhere that the differences between the Soviet and American stocks can be explained primarily in terms of an effort to conserve capital on the part of the Soviet engineering industry.⁴ This, in Granick's view, is the main factor behind the lathe-grinding machine imbalance, and also the lower relative proportions of boring machines and automatics and semi-automatics. A number of objections to this hypothesis can be put forward. First, Granick does not adjust the American census categories to bring them into line with the Soviet type classification; this leads to an exaggeration of the lathe-grinding machine imbalance and of the lower share of boring machines in the

1. Fredpriyatie, 1933, No. 12, pp. 10-11.

2. Omarovskii, op cit, p. 170.

3. SI, 1933, No. 10, pp. 8-12; see also Slavnye traditsii, op cit, p. 24.

4. Granick, op cit, pp. 183-189.

Soviet stock. Second, this approach is founded on the assumption that it is possible to classify individual types of machine tools as 'capital conserving' and 'relatively wasteful of labour' from the character of the machines themselves without regard to the specific features of each machine and the conditions of its use. But whether a lathe or a grinding machine, for example, is capital saving or otherwise depends on such factors as its degree of specialisation or automation, the nature of the workpiece, the required level of accuracy, the scale of output, the productivity of the machine (output per unit time), the level of utilisation of the equipment, the possibilities of multiple manning and shift work, etc. Third, no account is taken of the question of the skills required to operate machines of different types, but the fact that the underrepresented types were generally those requiring above average skills suggests that such an undifferentiated approach to labour is inadequate. Examples cited above provide evidence that in some cases capital was substituted for skilled labour ; in the machine tool industry this appears to have been quite a general phenomenon.

On the question of the lathe-grinding machine imbalance Granick does admit that structural factors may have had some influence , but believes that capital saving was the primary determinant. He considers that the relatively high share of lathes may have been influenced by the fact that castings were more widely used than in the USA , and that lower quality standards may have diminished the role of grinding machines. But the interrelationship between the relative proportions of lathes and grinding machines is not taken into account (poor quality semi-fabricates being rough turned instead of directly rough and fine ground), and the influence of the quality of semi-fabricates is overlooked. It was not just the case that relatively more castings were used, but also that all material inputs were of a lower quality , with larger allowances than usual in the USA. Therefore, lathes were not simply substituted for other types, but more lathes were employed in absolute terms than would otherwise have been necessary, i.e. this deep rooted structural influence , frequently beyond the direct control of individual enterprises, was wasteful of both capital and labour at the level of the enterprise , and probably for the industry as a whole.

Finally, Granick does not take sufficient account of the supply aspect, both in terms of the ability of the domestic industry to meet the demand for the more complex types and the ability of the various branches of engineering to obtain imported equipment. The minimisation of foreign exchange outlays was probably a much more powerful determinant of machine tool choice than any striving to conserve capital in general. In conclusion, we believe that Granick overstates the case for the influence of capital saving considerations on the choice of machine tool technology. The observed differences in the Soviet and American machine tool stocks can be best explained in terms of structural differences, the need to adjust for the scarcity of skilled machine tool operators, and supply factors.

The most striking fact about the Soviet and American machine tool stocks of the early 1930s is that, disregarding the lathe-grinding machine imbalance, a rapid process of catching up was taking place. The structure of the machines installed during the First Five-year Plan and, in particular, of those installed at new enterprises was very similar to that of the American stock showing that the Soviet engineering industry had gone far in adopting the latest, most advanced capitalist technology. More definite conclusions cannot be reached without analysis of two important factors, information on which is inadequate: the influence of scale differences, and of different levels of process and parts specialisation. Both these factors may have given rise to a bias against the more specialised types of machine tools. Finally, it would be of great interest to compare the Soviet stock with that of Germany or Britain, but unfortunately suitable information is not available.

Appendix FiveMILITARY PRODUCTION AND THE DEMAND FOR MACHINE TOOLS

Any discussion of the choice of machine tool technology during the years of the pre-War five-year plans is incomplete without consideration of the influence of the demands of military production. So long as the Soviet Union with its relatively weak economic base was the sole socialist country flanked to west and east by powerful capitalist states, the possibility of armed intervention was ever-present, necessitating the formation and maintenance of a military capacity large in relation to the economic strength of the country. The build up of military production, which effectively began from the beginning of the First Five-year Plan in 1929-30, exerted a profound influence on the industrial development of the nation; an influence which intensified in the course of the decade. Not only did this acquisition of a powerful military capacity require the development of specialised branches producing aircraft, tanks, artillery, small arms, ammunition, ships and other war supplies, but it also involved branches of civilian industry, notably engineering. This interpenetration of the military and civilian, and its implications, has to a large extent been neglected in studies of the Soviet economy of the 1930s. In this section an attempt is made to analyse the impact of military considerations on the engineering industry and its technology.

There are two components of this question of the impact of military demands on machine tool technology: first, what were the requirements of the specialised defence industry enterprises and, second, what impact did military considerations exert on the technology of the civilian sector? The former question can best be tackled by separately examining each main branch of military production and its specific requirements, but a number of general points can be made. First, in the event of war the role of military branches is to provide the maximum possible output in the shortest possible time - cost and profitability are secondary considerations although by no means unimportant. Second, most branches of military production experience regular changes of product sometimes of a radical nature and often imposed by innovations of the opposing military forces. Third, military

production under conditions of war must be so equipped as to permit the employment of manpower not normally engaged in the engineering industry in peacetime, e.g., unskilled female workers, young workers and other people with no previous experience of factory employment. At the same time the conditions of war provide little opportunity for proper training of new skilled workers and also technical and managerial personnel. This situation of scarcity of skilled workers may develop into an acute scarcity of workers of all kinds. Finally, the production technology must be such that the scale of production can be very rapidly increased at short notice if necessary. These demands are to a certain extent contradictory and their technical satisfaction presents considerable difficulties. Summarising the above demands, machine tools in the military branches must ensure high productivity, but also a large degree of flexibility, must be suited to operation by workers of very limited skills and possibly of below average physical strength, and at the same time should be quite simple to build.

The aircraft industry

There is no doubt that of all the branches of military production the aircraft industry exerted the greatest influence on machine tool building in the decade before the War. The rapid creation of a modern aircraft industry was probably the most outstanding technical achievement of the Soviet economy in the period of rapid industrialisation. Output of aircraft increased from 899 units in 1930 to 1,734 in 1932, jumping to 2,952 units in 1933 and reaching 4,435 units by 1937.¹ Expansion during the Third Five-year Plan period was particularly intense and, despite a major renewal of models from 1939, output rose to 8,331 units in 1940.² The potential for rapidly increasing output in the event of War was considerable: output in 1942 rose to 22,768 units even though many factories were evacuated to the east in 1941.³ The most machine tool intensive sector of the industry was the building of aeroengines, an activity

1. *Istoriya vtoroi mirovoi voyny, 1939-1945*, Vol. 1, M., 1973, p. 214; 1937 only - Klyuev, S.V., *Mify i pravda*, L., 1969, p. 57.

2. *Velikaya otechestvennaya voyna*, M., 1970, p. 44.

3. *Deborin, G.A. and Tel'pukhovskii, B.S., Itogi i uroki velikoi otechestvennoi voyny*, M., 1970, p. 184. For comparison aircraft output in Germany amounted to 8,295 units in 1939 and 15,556 in 1942 - *The effect of strategic bombing on the German war economy, 1945*, p. 277.

which involved a number of very large enterprises, notably those of Perm (Molotov), Rybinsk, Moscow, Zaporozh'e and Voronezh. At the end of the First Five-year Plan period aeroplanes were built at seven factories¹, but by 1939 there were at least 18 aircraft building enterprises, while a Central Committee decree of September 1939 provided for the construction of a further nine, three to be completed by June 1941.² From about 1937 enterprises of other branches of engineering were switched to the aircraft industry, including a combine harvester building factory transferred in that year;³ by the end of 1940 over sixty factories had been switched to the making of aviation products.⁴ The total size of the machine tool stock of the branch is not known, but according to Shakhurin, a former Narkom of the industry, there were tens of factories by the war with 5-6,000 units of equipment each, and employing tens of thousands of workers⁵, while another authority states that the aviation industry then had many tens of thousands of metal cutting machine tools and hundreds of thousands of workers and specialists.⁶ This suggests that the branch had at least 50,000 machine tools and possibly as many as 100,000 - a vast quantity if one considers that the total Soviet metal cutting machine tool stock in November 1940 was 710,000 units, and that the tractor industry, which developed so intensively during the First Five-year Plan period, had less than 10,000 machine tools at the end of 1933.⁷ It is claimed that in the last 18 months to two years before the outbreak of war both the total factory area and the quantity of equipment in the aviation industry almost doubled.⁸

The pre-war Soviet aircraft industry was a branch of large-scale production, combining sectors of individual and small serial production with large serial and mass output of basic models of planes and engines. In this respect it was in advance of the aircraft industries of other countries, which at this time were predominantly of the individual and small serial production type. The machine

1. Shavrov, V.B., *Istoriya konstruktsii samoletov v SSSR do 1938 goda*, M., 1969, p.420.

2. *Voprosy istorii*, 1974, No.2, p.83.

3. *ibid.*, p.90. (This was probably the Saratov factory, a major new enterprise of the First Five-year Plan, which definitely ceased production of combines during the 'thirties - Rozenfel'd and Klimenko, *op cit*, p.320).

4. *ibid.*, p.99.

5. *ibid.*, p.96.

6. Kravchenko, G., *Ekonomika SSSR v gody velikoi otechestvennoi voiny, 1941-1945*, M., 1970, p.176.

tool requirements of the plane-making sector of the branch differed from those of engine building. The former relied heavily on universal type equipment; the universality being needed to accomodate frequent design changes. The largest group of machine tools in the plane-making stock in mid 1935 was turret lathes of all types, in particular small machines of up to 38 mm diameter.¹ Automatics were used for making fasteners², but these were mainly of the single spindle 'Index' type possessing a quite high degree of universality (the first Soviet built automatics were of this type). But ordinary lathes ('DIP' and 'Udmurt') were also widely employed even in shops of serial and mass production. The second largest group was milling machines of all kinds of small and medium sizes; by mid-1935 these were mainly of Soviet production. Drilling machines, predominantly of the single-spindle, vertical type, formed the third largest group. Few grinding machines, apart from toolroom types, were used at this time. Chausskii in describing the industry's machine tool stock noted a tendency on the part of factory workers to 'over insure', i.e. to have universal type machines in all cases not only to provide for plane design changes, but also to cover shortcomings in the planning of technological processes; this factor must have played a role throughout the engineering industry at this time.

The aero-engine factories had a quite different stock of machines, both in terms of quantity and quality. Universal machines were employed, but specialised and special models occupied a large place, e.g. multi-spindle drilling machines, unit-construction type machines, camshaft and crankshaft grinding machines, and diamond-boring machines. High-productivity versions of more universal machines included 'Fay' type semi-automatic lathes, Bullard vertical, six-spindle lathes and gear-cutting machines of all types required in large number for making reduction gearing. But, unlike most other branches of the Soviet engineering industry at this time, a large proportion of the stock took the form of grinding machines. Thus the aero-engine industry posed a large demand for high-productivity

7. See Appendix 3, p. 460. For comparison, the aircraft industry of the USA had a mere 9,000 machine tools in 1940 (including forming machines), rising to 276,500 by the end of the War - *Mirovoe khozaystvo i mirovaya politika*, 1945, No. 11, p. 114 (citing *Business week*, 7.7.45.).

8. *Voprosy istorii*, 1974, No. 2, p. 96.

1. Chausskii, M., *Aviapromyshlennost'*, 1935, No. 6, pp. 26-30 for this and following paragraph.

machine tools of high standards of accuracy.

What influence did the aviation industry exert on the development of the Soviet machine tool industry? The specific demands of the branch were recognised from an early date. Zazar, writing in 1932, observed that the aviation industry presented unusually complex demands because machines had to have a large productive range adaptable to a variety of types of a given part, while at the same time high productivity was desirable in view of the scale of production.¹ The difference between the demands of the mass production motor industry and the aviation branch was stressed: the specialisation of machines appropriate to the former was unacceptable in the latter. Thus at a time when some specialists were putting forward the demand for a much greater degree of specialisation of machine tools built by the domestic industry, the aircraft building branch was calling for flexibility. It is evident that the aircraft industry did play a major role in determining the direction of development of the machine tool industry. Writing in 1935, Rinberg stated that, "The demands of the aviation industry on other branches were so great that they exerted a decisive influence on the profile and development of a whole range of branches of production (ferrous and non-ferrous metallurgy, machine tool building, electrical engineering, etc.). Thus, for example, in drawing up the Five-year Plan for machine tool building the aviation industry partially dictated to it technical demands, introducing into the plan about 200 types and sizes of machine tools, replacing machines hitherto imported".² Thus the tipazh drawn up in 1933 and refined in the following year was to a considerable degree shaped by the demands of the aircraft industry. This was indirectly confirmed by E. Levin of ENIMS at the first All-Union Conference of July 1933, when he revealed that after the NKTP order on removing machines from the import list Stankoob"edinenie had discussed requirements with a number of large-scale machine users - the first listed being the aircraft industry glavk (the second was the All-Union Gun-Arsenal trust).² The difficulty in tracing the influence of the aviation industry (and other military related sectors) lies in the fact that open reference to it was rarely made: in the press

1. Zazar, V.A. in K voprosu tekhnicheskikh sdvigakh vo vtoroi pyatiletke, M., 1932, pp. 153-154.

2. Stenogrammy, op cit, p. 90.

the 'auto-tractor' industry was frequently used as an umbrella term, which in fact covered the aviation industry as well. It appears that a compromise was reached between the demands of these major branches. Early in 1935 M.Kaganovich reported that a tipazh of 250 types and sizes had been drawn up for the aircraft industry, the types being unified with those to be built for the auto-tractor branch.¹ This solution may well have forced the motor industry to accept machines of a less specialised type than it desired.

The specialised machine tool industry and the main 'planned' enterprises were not the sole source of supply for the aircraft industry - it was itself a machine tool builder, meeting part of its demand, notably for special machines, from its own resources. The branch had its own machine tool building factory attached to the Moscow No.25 aeroplane works. This small factory, founded in 1931 for the production of special machine tools and fixtures for the aero-engine factories, is reported to have been well equipped.² Machine tools were also built in the repair shops of aircraft factories and at a number of FZU schools and branch technicums; notable was the school FZU of the 'Aviapribor' works, which built about 600 machines in 1934 and 1935, mainly bench-type lathes for precision work.³ The Aviatekhnikumy of the Taganrog, Rybinsk and Voronezh factories built a range of types, including shaping, drilling and tool grinding machines, and lathes.⁴ Many machines were supplied by the machine tool factory of TsIT, its highly adaptable unit-construction models being particularly well-suited to the industry's requirements, and at the end of 1940 the institute was united with the 'Orgaviaprom' trust, further strengthening its links with the branch.⁵

Writing in 1935 Chausskii claimed that by then the aircraft industry had been freed from foreign dependence with regard to machine tools: the growth of the stock was being secured predominantly with Soviet-built machines. Exceptions were large universal machines and special types not yet assimilated by the domestic industry. However, it is clear that the vast expansion programme of

1. Planovoe khozyaistvo, 1935, No. 3, p. 36.

2. Stenogrammy, op cit, pp. 78 and 166. ; Aviapromyshlennost', 1935, No. 6, p. 31.

3. ZaInd., 23.11.35.

4. Price lists and catalogues of various years.

5. TsIT i ego metody NOT, M., 1970, p. 54.

the immediate pre-war period did require the importation of machine tools on a substantial scale, not so much because the domestic industry was incapable of building them, but because it was overstretched and delivery times would have been excessively long. In June 1939, when the decision to build new engine factories was taken, 31 million rubles valuta was allocated for the purchase of foreign equipment, while in September of the same year plans for the construction of new plane works led to the allocation of a further 14 million rubles.¹ From early 1939 a vigorous campaign for the modernisation of the aircraft industry's production technology was initiated. Conveyerisation and flow organisation were expanded, and the use of special and specialised machines increased; lathes and turret lathes were replaced by automatics, and the use of such progressive technology as centreless grinders, broaching, honing, lapping, gear shaving and diamond boring was stepped up.² The great stress on high productivity equipment of these types in the machine tool industry's plans from 1939 must have been in part a response to the demands of the aircraft industry.

Summarising the influence of the aircraft industry on the machine tool building in the pre-war period it can only be concluded that it was considerable and an important factor in the drive for the domestic production of progressive types. At the same time the branch posed a large demand for such universal types as milling machines and turret lathes - significantly the basic products of the two new machine tool factories of the First Five-year Plan. The aero-engine branch was probably the major user of grinding machines and, in view of the limited domestic production of precision grinding equipment during the period, it is quite possible that aero-engine building effectively starved other lower priority / branches of these machines. Because of their lower priority these other branches were presumably unable to import much machinery. This may be an important factor in accounting for the relatively low share of grinders in the stock of most branches at this time. In general the high quality requirements of the aircraft industry must have exerted a positive influence on the machine tool branch, forcing it to raise its standards and adopt more refined methods of work.

1. *Voprosy istorii*, 1974, No. 2, pp. 83-84.

2. See Tsonev, V. et al., *The Soviet aircraft industry*, Chapel Hill, 1955, pp. 162-168.

Artillery, Small Arms and Ammunition

The production of artillery, small arms and ammunition required a large machine tool stock and appears to have been carried out at specialised enterprises, many dating from before the Revolution. A number of the leading factories of this branch of the defence industry had machine tool building shops which made a substantial contribution to the development of machine tool building in the USSR. Notable among these were the Tula, Izhevsk, im.Kalinina (Leningrad), Lugansk No.60, im.Frunze (Penza), im.Volodarskogo (Ul'yanovsk) and Podol'sk No.17 factories. These enterprises built a wide range of universal, specialised, special, and precision machines, many of which were installed in civilian branches of the engineering industry. These enterprises presumably built highly special types specific to the munitions industry - this was certainly the case at Tula which had a very long tradition of special machine tool building dating back to the eighteenth century.

The basic types of machines installed at the gun and small arms factories were presumably, following foreign practice, general purpose models supplemented by special and specialised equipment, notably for boring gun barrels. The 'Krasnyi Proletarii' factory built deep drilling machines and long-bedded lathes of the types used in artillery production from the middle of the Second Five-year Plan period, and many special heavy machines for gun barrel turning, boring and rifling were produced in the Third Plan period.¹ But despite the efforts of the domestic industry not all needs could be met and in the two-three years before the War a large quantity of special equipment for the artillery and gun industry under NKV was imported. At this time (1939?) the Party Central Committee and SNK USSR allocated about 200 million gold rubles to NKV for additional imports of special machine tools and other equipment.²

During the First World War the production of ammunition had been largely carried out using simple, general-purpose machines suitable for manning by

1. Price lists of various years.

2. Voprosy istorii, 1969, No.1, p.131.

unskilled workers. The basic types of machines employed in the industry were simple general-purpose lathes and also thread milling machines: both these types were built by the im.TsK Mashinostroeniya factory in Kuibyshev during the 1930s. In the pre-War period attention was devoted to the creation of simplified universal and specialised operational type machines for munitions production, some being obtained by modernising and modifying the existing stock of universal machines. Large numbers of simple operational lathes and other types were in fact built for the branch during the war itself, many by the enterprises of the munitions and mortars commissariats.¹

Some time before the War the German munitions industry began to turn away from the use of simple standard machines, replacing them by a range of new heavy-duty, single and multi-spindle semi-automatic and automatic lathes designed for very high productivity munitions production with workers of low skills. Unlike most operational machines these new types were designed for use with super-hard alloy tools. This move was prompted by considerations of labour availability, the new machines giving considerable savings, and also by the fact that they gave substantial savings in factory floor space compared with the simple, operational machines. This development was followed with interest in the Soviet Union and its benefits in terms of raised productivity and reduced labour skill requirements were propagated in the technical press.² It seems probable that the very considerable emphasis on the building of automatics and semi-autos. from 1939 was in part a response to these new possibilities in munitions production. But while progress in the use of both operational and automatic types was undoubtedly made before the outbreak of War, the basic equipment of the munitions factories appears to have been of the universal type. It is notable that the prominent engineer, Satel', in a work published in 1943, referred to the predominance of universal type equipment at enterprises producing military products, and found it necessary to propagate the advantages of creating operational and simplified universal machines.³

1. Aizenshtadt and Chikhachev, *op cit*, pp.330-334.
 2. *Mashinostroitel*, 1939, No.9, pp.11-18. Although ostensibly about western developments this article strongly suggests that Soviet engineers were divided on the relative merits of the old and new technology. pp.45-46.
 3. Satel', E., *Tekhnologiya i tekhnicheskie resursy mashinostroeniya*, M.-Sverdlovsk, 1943.

Armoured Fighting Vehicles

To a greater extent than in the other main branches of the defence industry tank and military vehicle production relied on the capacity of existing civilian enterprises, rather than specially constructed new factories. The tank industry was basically a product of the First Five-year Plan: production rose from a mere 170 tanks and light tanks (tankettes) in 1930 to 3,038 units in 1932¹, a high proportion being the small T-27 tankette. Output averaged about 3,100 units a year from 1935 to 1937², but fell somewhat in quantity terms during the Third Five-year Plan period as the industry strived to introduce new, heavier models, notably the T-34 and KV. Output in 1940 was 2,794 units, rising to 24,719 units in 1942.³ The main tank building factories before the War were the im.Kirova (Putilov) works in Leningrad (the pre-War base for the KV tank), the Khar'kov locomotive works im.Komintern (the pre-War base for work on the BT series and the T-34), and the Leningrad 'Bol'shevik' factory. But it is clear that the three new tractor factories were also intended to provide a base for tank building and that tanks and artillery tractors were built at all three at times before the War.

There are two aspects to the tank building activity of the tractor factories. First, the main production shops of the enterprises appear to have been deliberately projected with the possibility of switching to tank production in mind.⁴ This is acknowledged in the case of the Chelyabinsk factory by Vannikov, later NarKom of armaments, who was in charge of the equipping of this works at the time of its construction⁵, and supported by Western specialists who worked in the USSR.⁶ Hence it is reasonable to assume that the tractor factories were not supplied with as much very highly specialised equipment as they would have been if intended solely for tractor building. Even in the initial stages of the work of these factories military work was undertaken, e.g. the Khar'kov factory failed to fulfil its 1932 plan for tractors because it was loaded with a large order for the

1. Istoriya vtoroi mirovoi voyny, 1939-1945, op cit, p.214.

2. Voprosy ekonomiki, 1970, No.5, p.14.

3. Deborin and Tel'pukhovskii, op cit, p.183. For comparison production of tanks in Germany (excluding occupied territory) was 1,459 units in 1940 and 4,137 units in 1942 (The effects of strategic bombing..., op cit, p.278).

Khar'kov locomotive factory; an order which required the allocation of a major part of the enterprise's equipment and technical skills. This major order was almost certainly assemblies for tanks built at the locomotive works.⁷ Second, tank building appears to have been carried out on a fairly regular basis at shops attached to the tractor factories, i.e. without disrupting the basic production,⁸ and this method probably provided a means of devising and verifying technological processes in preparation for the conversion of the whole works. Both the Chelyabinsk and Stalingrad factories began building the KV and T-34 tanks respectively in 1940.⁹

The machine tools required for tank building are of the heavy-duty, general purpose types similar to those required for making rail transport equipment. During the 1930s reference s to 'rail transport machine building machine tools' probably covered the tank industry as well. The building of these heavier types and of special equipment for rail transport was one of the weaker sectors of the domestic machine tool industry at least until the end of the Second Five-year Plan, although a tipazh of such machines was discussed by the Third Conference of Designers in 1935. The sole producer appears to have been the Gor'kii 'Dvigatel' Revolyutsii' works, which built a range of special wheel and axle lathes. In the Second Five-year Plan it was evidently the intention to build heavy rail equipment machine tools at the new Chelyabinsk heavy machine tool works then under construction. This enterprise is something of a mystery. Its construction was initiated by a decision of the Central Committee of 15th May 1930 which provided for the building of sixteen giant engineering factories in the Urals.¹⁰ Work began in 1931 and by early 1935 its tool room started operation, but the main machining and assembly shop was not commissioned until 1937.¹¹ In 1935 its director, Kattel', explained that this vast factory, with a planned

4. In this connection it should be noted that at the time of planning and construction of these factories tanks were generally smaller in size and lighter than they became later in the decade, so that the technical problems of rapid conversion were probably less demanding in the early years than they actually were just before and during the War.

5. Voprosy istorii, 1969, No. 1, p. 133.

6. For example, an American armaments industry consultant, E. Lowry, observed in 1939 that the Chelyabinsk and Stalingrad tractor factories 'could be turned over to small tank production, almost at the wink of an eye'. In Lowry's view the dual purpose nature of the enterprises was a major reason for the relative inefficiency of the Soviet tractor factories compared with American equivalents (The iron age, 5th Oct., 1939, pp 35-36).

size of twice that of the neighbouring tractor factory , was to produce large machine tools (440 a year of twenty types and sizes) and vital parts for rail transport machine building, including wagon axles, and roller bearings for rail equipment.¹ Machine tool building began on a small scale in 1935 , and in 1937 the first '1D64' lathe was built prior to its serial production in the following year.² Critical reports at this time pointed out that the factory should by then have become the base for building vertical turning and boring machines and other equipment required by the rail transport industry.³ Machine tool building was carried out in the Third Five-year Plan years⁴, but the primary activity of the enterprise was probably, as a well-informed American observer suggests, the production of tanks or, at least, parts and assemblies for tank building.⁵ This is supported by the fact that metallurgical capacity was added by 1941 and after the outbreak of War in November 1941 a number of the shops of the works were separated off as a factory of transport machine building⁶, and this may well have entered the Chelyabinsk 'Tankograd' complex. Thus it is probable that the tank industry did have its own machine tool building base in the Urals before and during the War.

The building of tank engines did require more specialised , high-productivity machine tools. During the 'thirties tank engines were built by the Khar'kov locomotive factory in its diesel engine shop and during the Second Five-year Plan a major new enterprise, the Khar'kov diesel engine factory, was built alongside the locomotive works specifically for making tank diesel engines. Production of this large, modern factory began in 1939, one of the main products being the 'V-2' engine developed at the neighbouring works, which provided the basic power source of Soviet tanks of the World War.⁷ The Stalingrad tractor

7. *Istoriya khar'kovskogo traktornogo zavoda im. Ordzhonikidze*, Vol. 1, Khar'kov, 1960, p. 173. See Sutton, *op cit*, Vol. 2, pp. 238-239 for further evidence of tank building at Khar'kov and Stalingrad during the First Five-year Plan.

8. A special tank building shop was under construction at Stalingrad in 1932 (Hilger, G. *The incompatible allies*, New York, 1953, p. 246); at Chelyabinsk this activity apparently occupied the factory technical school (Sutton, *op cit*, p. 243).

9. Kravchenko, *op cit*, p. 74; *Letopis' chelyabinskogo traktornogo M.*, 1972, p. 209.

10. Sogrin, G. V., *Perelisty vaya stranitsy*, Chelyabinsk, 1968, p. 228.

11. *Ibid.*, pp. 52 and 230.

1. *ZaInd.*, 3.12.35.

2. Sogrin, *op cit*, pp. 53-60.

3. *ZaInd.*, 14.5.37; 29.6.37.

4. Sogrin, *op cit*, p. 83.

factory also built tank diesel engines before the War.⁸ In the early part of the War the Khar'kov diesel engine works, together with the Leningrad Kirov tank factory and parts of other enterprises were evacuated to the Chelyabinsk tractor factory to form the 'Tankograd' complex, the base for the production of the 'KV'.⁹ The Khar'kov locomotive factory was evacuated to the vast wagon works of Nizhniy Tagil to form the Urals tank factory No.183, the main base for building the 'T-34'.¹⁰

Military Production and Civilian Enterprises

The specialised defence industries formed only part of the base for military production in the pre-war years. There was clearly a major effort to organise arms production at the factories of civilian machine building and to prepare for a quick conversion to such production in the event of war. As early as June 1926 the Politbureau stressed the necessity of providing for rapid conversion to military production at new and reconstructed factories of Glavmetall.¹ Evidence on the extent to which convertability was taken into account at new enterprises built during the First Five-year Plan is not available. In 1932 some enterprises were hastily switched to the production of military related products, e.g. the Khar'kov factory, the im. Kirova works in Leningrad (the turbine and tractor building shops of which were switched to making tank parts and, later, full tank production); the im. Dzerzhinskogo factory in Perm' was switched from the machine tool industry to defence production, and at about this time part of the Podol'sk sewing machine works appears to have been transferred to the defence industry. This action in response to the deteriorating situation in the Far East, coupled with the rise to power of Hitler in 1933, must have made ease of convertability a highly desirable feature of all new capacity from this

5. Scott, J., Beyond the Urals, London, 1943, p. 89. Scott claims that 'Stankostroi' was originally conceived as a light machine building plant but reprojected in the early 'thirties for tank production.

6. Sogrin, op cit, p. 230.

7. Letopis' chelyabinskogo traktornogo, op cit, p. 225.

8. Kravchenko, op cit, p. 74.

9. See Slobodin, K.M., Tank na postamente, M., 1968, pp. 3-25.

10. Likhomanov, M.I., Organizatorskaya rabota partii v promyshlennosti v pervyi period velikoi otechestvennoi voyny, 1941-42gg., L. 1969, pp. 63 and 170.

1. Industrializatsiya SSSR, 1926-1928, M., 1969, p. 509.

time on. But it was during the Third Five-year Plan that the militarisation of civilian engineering became a widescale phenomenon. It is evident that from about 1937 very many enterprises of the machine building industry were prepared for military production or actually began such production. At enterprises of the tractor, agricultural machinery, machine tools, ship building and other branches 'special shops' were organised at which the technology of the chosen military product was developed and checked, cadres prepared and, in many cases, batch production started.¹ Control over mobilisation preparations was in the hands of the enterprise NKVD organisation, together with military aides, and they had the right to rearrange equipment and disrupt the normal flow of work of the enterprise in the interests of securing rapid conversion.² From about 1937 an increasing number of civilian factories were switched to the defence industry, e.g. some engineering enterprises were transferred to the production of artillery in 1937, and more in 1939-41.³

The need to secure rapid conversion of civilian factories to military production must have exerted an influence on the choice of machine tool technology and production organisation. Narrowly specialised types were clearly inappropriate: adaptability was a primary requirement, but adaptability coupled with high productivity was presumably the best solution. It was appreciated at quite an early date that the unit-construction principle offered great advantages in this respect. Vishnev, a leading Soviet expert of the capitalist war economy and technology, wrote in 1935 of the rejection of the principles of narrow specialisation and operational differentiation and the transition to new machines of the unit-construction type, combining operations and providing flexibility. These highly productive but flexible machines, he wrote, had great significance for the defence industry, which had to provide for frequent product changes; but, "...still more important is the fact that the introduction of such machine tools in civilian industry (in particular vehicle building) will to an enormous degree facilitate the task of converting to war production".⁴ Significantly, unit-

1. This is confirmed by a number of Soviet and Western sources - see Vannikov, *Voprosy istorii*, 1969, No. 1, p. 133; Khavin, A. F., *Kratkii ocherk istorii industrializatsii M.*, 1962, p. (engineering factories in the Urals); Lowry, *The iron age*, 5th Oct., 1939, p. 35; Sutton, *op cit*, Vol. 2, p. 344.

2. Lowry, *loc cit.*; Wolin, S and Slusser, R., *The Soviet secret police*, London, 1957, p. 121.

construction type machines were chosen for machining a number of basic components at the expanded and reconstructed auto-tractor factories in 1936 and 1937. A large number of unit-construction type machines were in fact built for the defence industries during the War, their high productivity permitting the replacement of many ordinary machines and freeing many skilled workers; at the same time new designs were evolved permitting the economic application of unit-construction machines in serial, as opposed to mass, production.⁵ But unit-construction type machines were generally only suitable for machining certain basic components produced in very large quantity, notably in engine building for aircraft, tanks and other vehicles. For other parts and products the desire for adaptability probably reinforced the bias to universal type equipment already existing in the industry because of the circumstances of production at the enterprises and the limited domestic production of more specialised machines.

Conclusion

There is no doubt that the demands of the defence industry exerted a strong influence on the Soviet machine tool building in the pre-War years and that they helped to shape the structure of output and the pattern of machine choice in the engineering industry. The nature of the demands was such that adaptability became a basic requirement; within the defence industry in order to allow for frequent design changes, and in the civilian branches for rapid conversion in the event of war. At the same time Soviet design policy during the period always placed great stress on the need for simplicity of control of machines - an essential requirement for production in war time conditions, and during the immediate pre-War period automation was given high priority as a means of deskillling many types of machines. The very rapid transition to military production achieved by many Soviet engineering enterprises in the initial period of the War indicates that the machine tool stock must have corresponded well to the new demands: the machine tool industry's own factories, for example, were almost immediately

3. 50 let vooruzhennykh sil SSSR, M., 1968, pp. 201 and 224.

4. ZaInd., 9.9.35; see also Problemy ekonomiki, 1936, No. 4, p. 61.

5. Aizenshtadt and Chikhachev, op cit, pp. 335-347.

switched to making tank parts, shells and other items.¹ In another respect the demands of such branches as aero-engine and diesel engine building led to pressure for the domestic production of progressive types such as broaching machines, all types of grinders, lapping and honing machines, diamond boring machines, etc., while the very high quality standards for machining must have helped to raise the overall technical level of the machine tool industry.

The implications of military demands for Soviet machine tool building considered above are given support by the experience of the USA during the war. Pre-War preparation was on a much smaller scale than in the USSR and much of the equipping of industry to meet war demands took place in the period 1942 to 1945. As Wagoner, the historian of the American machine tool industry, observes, during the War there was at least a partial suspension of the trend towards the specialisation of machinetools, and increased production of the more standardised general purpose types.² He also notes a tendency for defence contractors to order general purpose equipment with all possible accessories even when simpler machines would have been adequate: this tendency to 'over insure' stemmed from a desire to provide for all possible future circumstances of both new defence orders and subsequent peacetime production. The Soviet modernisation and automation campaign of the Third Five-year Plan period aimed at increasing productivity and deskillling the existing stock is also interesting in the light of American experience that, while older machines could be employed for defence production, their productivity^{was} inferior and they required more labour of higher skills than newer machines, and for these reasons were not favoured.³

Taking a broader view, the impact of military demands on the machine tool industry was clearly not restricted to the question of technical choice. Military considerations must have been to the fore in the pressure for import substitution in the Second and Third Plan periods, forcing the industry to take on tasks which could otherwise have waited until a firmer foundation had been established.

1. *Istoriya SSSR*, 1971, No. 6, p. 97.

2. Wagoner, *op cit*, p. 260.

3. *ibid.*, pp. 236 and 260.

A NOTE ON 'CONTINUOUS FLOW' ORGANISATION IN THE ENGINEERING INDUSTRY

It has been argued by Granick¹ that in the First Five-year Plan period the Soviet engineering industry adopted a policy of "investing heavily" in continuous flow organisation, with the result that in 1932 there was "an amazing concentration in machine building as a whole on mass production and on continuous-flow arrangement of equipment", whereas in 1929 mass production methods "were virtually non-existent in Soviet machine building".² Continuous flow organisation he argues, was regarded as "a peculiarly American technique of manufacture". But, in Granick's view, this investment in continuous flow organisation (more accurately in large, new plants organised on a flow basis) was a failure: "The Soviet effort to introduce continuous flow methods during the early 1930s was thoroughly misplaced. It represented an attempt to push the metal-fabricating industry into quite advanced production techniques while skipping over the historically normal intermediate stages. The results were negative, and a retreat to the establishment of necessary preconditions was imposed upon Soviet management".³ The 'retreat', Granick believes, took the form of an abandonment of flow organisation in the 1930s, although he does concede that his evidence for this is only indirect.

Space does not permit a detailed examination of this question, which is not of central importance to the present work. However, some comments are felt to be necessary, both in general, and in relation to the machine tool industry.

1. Granick throughout employs the term 'continuous flow' production, although in Soviet usage of the period 'flow' production had a broad meaning and encompassed non-continuous forms not posing such strict organisational and planning demands as the fully-fledged, rhythmic, continuous flow form. The definition of 'flow production' is discussed in the appended note. Here it should be noted that the definition of 'flow' arrangement employed in the 1932 machine tool census (the source of Granick's evidence on flow production) was a broad one. Finally, in discussing flow production distinction must be made between machining and

1. Granick, *op cit*, pp. 24-27; 110-115; 124-125.

2. *Ibid.*, p. 26.

3. *Ibid.*, p. 115.

assembly processes.

2. It is not strictly true to say that mass-production methods were virtually unknown in Soviet machine building in 1929, or that industry had no experience of flow organisation. Before the First World War the only Russian engineering factory with mass-flow (assembly) production was the Podol'sk sewing machine works of the Singer company, but during the War mass production machining methods were quite widely adopted for the production of shells and other military products.¹ In the 1920s there was considerable interest in developing flow production in Soviet industry as a component of the rationalisation movement, which was inspired to a great extent by the German experience of applying and adapting American mass production techniques. Conveyerised assembly on a flow basis was introduced at the Khar'kov 'Serp i Molot' agricultural machinery factory in 1926² and by the time of the First All-Union Conference on Continuous-Flow Work in 1928 there were quite a few engineering enterprises of a number of branches which had introduced elements of flow work, primarily for assembly processes; these included the Podol'sk sewing machine factory, the Tver' wagon factory, several enterprises of the Uktrestsel'mash, and electric motor building works, including 'Elektrosila', 'Elektrik' and the Khar'kov electro-mechanical factory.³ Furthermore, continuous flow organisation was then envisaged for a number of new enterprises including the Stalingrad tractor factory, Rostsel'mashzavod, and the Lyuberețsk combine factory. There is no doubt that German technical assistance was received for organising flow production, eg. one of the main reports at the conference in May 1928 was presented by a German expert attached to NK RKI (the organisation most prominent in promoting flow production at the time); Peppelmann, who spoke on flow production abroad and in the USSR, put particular stress on the possibilities offered by flow work for employing workers of relatively low skills.⁴ The German specialist, Schlesinger, was a consultant at both the Putilov tractor works and the AMO vehicle factory - two of the first to develop flow production on a regular basis.⁵ At both these enterprises the machine tools were arranged according to work flow⁶ and this was also the case at the 'Elektrosila'

1. Rozenfel'd and Klimenko, *op cit*, p.126; *The Russian economist*, Vol.1, No.4, July-September, 1921, pp.1153-1157.

2. Makeenko, M.M., *Ocherk razvitiya mashinostroeniya SSSR v 1921-1928gg*, Kishinev, 1962, p.157.

factory.⁷ The defence industry enterprises appear to have been pioneers in this respect. As early as 1926 it was reported that the Tula and Sestoretsk factories making guns, machine guns and revolvers, had shops specialised for the production of particular items with machine tools arranged according to the flow of work.⁸ Thus by 1929, drawing on German experience, the Soviet machine building industry did have some experience of flow organisation of both assembly and machining processes. The system offered the possibility of raising productivity and reducing costs with little additional capital outlay and with the further benefit that the associated differentiation of operations facilitated the employment of low skilled workers.

3. It is true that, as Granick observes, one fifth of the stock of machine tools in the production shops of enterprises of the machine building industry in April 1932 were installed in a flow arrangement,⁹ and that a relatively high share of new machines installed in the years 1929 to April 1932 were arranged according to work flow (one third). Furthermore, over sixty percent of the machines installed in the production shops of new enterprises established in the 1929 to April 1932 period were installed on a flow basis. However, this picture requires some qualification. Forty five per cent of the flow-arranged machines in April 1932 were located at old enterprises, i.e. founded before 1929, including almost forty per cent of the total at enterprises dating from before the Revolution. A large proportion of these machines must have been existing old models rearranged on a flow basis in the Soviet period. This needs to be stressed because Granick asserts that flow arranged machines were heavily concentrated at new factories.¹⁰

In considering flow organisation in 1932 it is essential to look at the branch structure - an aspect not examined by Granick. As shown elsewhere,

3. Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami, op cit, p.53; Ratsionalizatsiya promyshlennosti SSSR, M., 1928, p.294.

4. Torg.-prom.gaz., 24.5.28.

5. ibid., 30.8.28; Byli industrial'nye, M., 1973, p.152.

6. Maevskii, I.V., Tyazhelaya promyshlennost' v pervye gody sotsialisticheskoi industrializatsii (1926-1929), M., 1959, p.127; Direktor - I.A.Likhachev, M., 1971, p.11

7. Torg.-prom.gaz., 23.5.28.

8. Sistema i organizatsiya, 1926, No.1-2, p.6.

9. For this and following see Appendix 3, pp.466-468.

10. Granick, op cit, p.112.

over fifty five percent of all flow-arranged machines in April 1932 were installed in only three branches which all developed vigorously during the First Five-year Plan, i.e. tractor building, vehicle building and the production of agricultural machinery.¹ A further 17 per cent were machines in the clothing-footwear machinery branch, mainly those of the Podol'sk factory dating from before the Revolution and having flow production before the First Five-year Plan. The only other branches with notable proportions (between 15 and 20 per cent of their stocks) were the machine tool industry itself, electric power equipment (probably the making of small electric motors), and the production of communications equipment. In the case of the machine tool industry and other branches with some flow-arranged machines it is probable that only the machines of certain shops and sections were so arranged, in cases where specialised, quantity production of certain parts and assemblies could be secured. Considering the scale of production adopted for the auto-tractor industry flow arrangement was the only rational form of organisation at that time, being widely employed in these branches not only in the USA, but also in Europe. Thus, flow-arranged machines were predominantly to be found in the mass and large-serial light and medium machine building branches intensively developed in the 1929-1932 period: the chosen priorities of branch development predetermined the bias towards flow organisation.²

4. The above comments are relevant to Granick's thesis on the 'abandonment' of continuous flow production in the mid-1930s. Like Granick, we have found no direct evidence to support this thesis. What in fact probably happened during the Second and Third Five-year Plans was that the use of flow organisation gradually increased, but the share of machines in the total stock arranged on a flow basis and the proportion of output accounted for by mass-flow enterprises declined. This process was clearly underway even in the First Plan period itself:

1. Appendix 3, p.467.

2. In contemporary sources alternative statistics were frequently cited to demonstrate a massive shift to mass and large-serial production during the First Five-year Plan period: in 1932 48.6 per cent of machine building production stemmed from mass production enterprises (including 35.4 per cent from mass-flow), 40.6 per cent from serial production enterprises and only 10.8 per cent from enterprises of individual production. This was contrasted with American data for 1927 - 41.9 per cent mass production, 22.4 per cent serial production, and 35.7 per cent individual production (Plan.khoz., 1934, No.1, p.70). The Soviet proportions
cont. next page.

In the last nine months of 1932 and in 1933 the branch structure of installations shifted - the role of mass-flow branches declined, but that of individual and serial production branches rose.¹ There is no evidence that flow production was abandoned at the auto-tractor factories and, presumably, the extensions of the main enterprises during the Second Five-year Plan were also founded on flow principles. The new im.KIM light car factory developed during the Third Plan was definitely planned for flow production - its deputy chief engineer, F.S.Demyanyuk, a leading Soviet expert on flow production, noted in 1940 that the principle of potochnost' had been applied even more widely and deeply in both machining and assembly shops than at any of the existing automobile factories.² But some of the other branches with a relatively high level of flow organisation in 1932 probably experienced a slower rate of growth in subsequent years, notably agricultural machine building, but possibly also the production of clocks, watches and photographic equipment, and the making of electric motors. Thus, we believe that the high proportion of flow production indicated by the April 1932 census was a temporary phenomenon produced by the structure of branch priorities in the previous three-years and the speed of completion of construction of enterprises. The absolute level of use of flow organisation probably rose in the 'thirties, but its relative share declined.

Evidence for a continued extension of the use of flow organisation can be found for the machine tool industry itself. In 1932 16 per cent of the branch's total stock of machine tools in production shops were arranged on a flow basis, and presumably the 'Krasnyi Proletarii' accounted for a substantial proportion.³ The new Gor'kii and im.Ordzhonikidze factories (~~excluded from the census~~) do not appear to have been organised in this way at first: it was reported in 1937 that the former had a group arrangement of equipment, while the latter switched

were clearly influenced to a considerable extent by the rather unusual branch structure prevailing in 1932. While not denying the considerable achievement in developing mass production during the First Five-year Plan, these figures should be treated with caution. The seriality of production is here defined (for the USSR at least) in terms of the organisation of assembly processes, and enterprises engaged in mixed forms of production were classified according to the dominant type. But 'flow' assembly covered any form of assembly in which products passed from one operation to the next according to the flow of work regardless whether the operations or the movement of the products were mechanised. (*ibid*). Thus, according to this definition flow production items included about three-quarters of the 1932 output of the wagon building branch (all non-mechanised flow), over

to an arrangement according to specific components and assemblies in the preceding year, suggesting that elements of flow organisation were adopted.⁴

While evidence on flow organisation in machining shops is sparse, there is information on flow assembly processes which does suggest that its use increased during the period. Given that Granick's thesis rests on the argument that Soviet management was unable to cope with the organisational aspects of flow production this is of some importance because flow assembly also requires strict work scheduling and interchangeability of parts. The adoption of flow assembly in the machine tool industry from about 1937 has been considered elsewhere⁵. The aircraft industry had a major campaign for the introduction of conveyerised flow assembly in the Third Five-year Plan period at both engine and plane factories.⁶ Furthermore, in 1938 it was reported that continuous flow assembly methods had been applied not only at mass production enterprises of light and medium machine building, but also at a number of enterprises of heavy engineering with a low seriality of production e.g. 'Russkii Dizel' and 'Elektrosila' where an output as low as 600-900 units of a given motor a year was considered adequate for flow organisation.⁷ The application of flow methods to serial production in a number of branches of industry, including aircraft building, machine tools and bearings production was one of the basic directions of work of the Central Institute of Labour during the 1930, with particular emphasis on multi-product flow lines.⁸ Granick suggests that the widening product ranges of the mid-'thirties may have accounted for the 'abandonment' of flow production, citing the case of the machine tool industry as a branch in which the range rapidly widened. But this branch was not one in which flow methods played a prominent role in 1932, and the widening product range did not prevent the adoption of elements of flow assembly at a number of leading enterprises. Finally, Granick cites one 1940 source which makes no reference to continuous flow production as evidence in support of his case, but it is notable that another major work of the same year

two-thirds of all agricultural machinery, almost one hundred percent of the auto-tractor industry's output, over forty per cent of communications equipment and fifteen percent of all output of locomotives: the high proportion of reported flow production is thus understandable. (see *Sotsialisticheskoe stroitel'stvo SSSR*, 1935, p.66.)

1. See Appendix 3, p.460.

2. *Mashinostroitel'*, 1940, No.4, p.3.

observed that this form of production had wide application in branches of mass machine building - auto-tractor building, and the production of sewing machines, motorcycles, bicycles, etc.⁹

In conclusion, we believe that the Soviet authorities consulted by Granick who denied that there had been an abandonment of flow production during the 'thirties were correct'.¹⁰ The high indicated level in 1932 was a product of the timing of the census: from then on the relative share of flow production declined but its application in absolute terms probably increased, rising more sharply during the War from 1942. The introduction of flow methods was not a failure and it certainly cannot be said that the effort to introduce flow production was 'thoroughly misplaced'. Finally, Granick claims that this example demonstrates that the Soviet attempt to adopt the quite advanced production technique of continuous flow shows the folly of trying to skip over 'historically normal intermediate stages'. But in the Soviet case no stages were 'skipped over': individual, small batch and large batch production methods were all well known and mastered long before the First Five-year Plan and, as described above, some experience of flow organisation had been gained before the Plan commenced. Flow production was the next stage for the Soviet engineering industry - the successes of the vehicle and tractor factories (despite the initial problems of assimilation at Stalingrad) amply demonstrate that Soviet engineers and managers were quite capable of meeting the challenge.

3. The factory switched from a group arrangement by type of machine to specialised sections for particular components and assemblies with the transition to the 'DIP' model (Slavnye traditsii, op cit, p.119)

4. ZaInd., 2.2.37.

5. See p.

6. 'Conveyerisation' of aero-engine factories began in 1937 - Mashinostroenie, 4.3.40.

7. Aviapromyshlennost', 1938, No.6, p.37.

8. Tsit i ego metody NOT, op cit, pp.129-136; 167-180.

9. Granovskii, E. and Markus, B., Ekonomika sotsialisticheskoi promyshlennosti, M., 1940, p.196.

10. Granick, op cit, pp.124-125.

A Note on the Definition of 'Flow' Production

In view of the rather loose usage of this term met in the literature it is useful to clarify the meaning of 'flow' production understood by Soviet writers of the pre-War period. The term 'flow' (potochnaya) production was first introduced by the prominent engineer, Professor A. Pankin, in 1926 as a Soviet equivalent of the German term 'fliessarbeit' to describe a form of organisation of shops and equipment securing a straight flow of work through an enterprise; previously the loose term 'fordizma' had been employed.¹ But the 'flow' arrangement of machines in itself simply refers to the placing of machines in consecutive order according to the sequence of work processes and can cover a number of forms of production organisation. In the 1930s two main variants were identified: first, 'group' production (or 'formal' flow work); second, continuous flow (rabota nepreryvnykh potokom). Group production was characterised by the arrangement of the machines and workplaces according to the path of movement of components and assemblies; the diversity of the time of individual operations, and the existence of inter-operation stocks. Mechanical transport devices could be employed, giving mechanised or moving, group, flow production. Continuous flow production, best suited to mass produced components, assemblies and finished products, was distinguished by the fact that the length of each operation was equal or almost equal, giving a continuous, rhythmic flow of work, without inter-operation breaks and stocks. This form was often associated with conveyers and other forms of mechanised transport, for both assembly work and the transfer of parts between machines. The machine tools employed in continuous flow production were devoted to the machining of a given, fixed part.²

In the 1932 Census of metal working machinery a broad definition of 'flow' production was adopted. The census basically distinguished between the arrangement of machines in groups according to their type or size, and arrangement according to the flow of work, i.e. both group and continuous flow production were included. Furthermore, machines were regarded as arranged on a flow basis even if they were in groups by type of machine if operations were performed consecutively according to the path of work.³ There is no indication from the census of the role of continuous flow production properly defined. In popular usage in Soviet writings of the pre-War period, in particular in the late 1920s and the First Five-year Plan period, all types of 'flow' production were indiscriminately termed 'continuous flow'. And at this time enterprises were generally categorised as being of the 'mass-flow' type according to the organisation of assembly processes rather than of their machining shops.

1. Sistema i organizatsiya, 1926, No. 1-2, p. 6.

2. See Rotshtein, A., Osnovnye problemy promyshlennoi statistiki, M., 1934, pp. 135-137;

Trofimov, I. P., Aviapromyshlennost', 1938, No. 6, pp. 37-38.

3. Oborudovanie, op cit, vyp. 4, p. 18.

THE MACHINE TOOL BUILDING ACTIVITIES OF THE CENTRAL INSTITUTE OF LABOUR

The Central Institute of Labour (TsIT) was founded in 1920 by Aleksei Kapitonovich Gastev (1882 - 1941) for the study of the scientific organisation of labour (NOT). Gastev was one of the leading 'proletarian poets' both before and immediately after the Revolution and also a leader of the metal workers' trade union.¹ In the 1920s the Institute, at first under the central council of the trade unions and later under NKTP, was primarily occupied with problems of NOT, and also the training of workers by techniques specially developed by Gastev for rapidly inculcating basic productive skills.² The achievements of the Institute were put into practice by a limited company, later trust, 'Ustanovka', which in effect acted as a khozraschet innovation and labour training organisation. By 1935 TsIT employed over a hundred workers, 'Ustanovka' over three hundred, and the latter had two experimental factories, No.1 employing 600 workers and No.2 employing 285.³ Gastev was director of the Institute from its foundation until 1938, and from 1932 to 1936 was also chairman of the All-Union Committee for Standardisation of STO. He was a prolific and highly original writer on problems of NOT, training, standardisation and machine tool design and use. In 1938 he was removed from the leadership of the Institute, a victim of the purges. In 1940 TsIT was combined with the trust, 'Orgaviaprom' and subsequently transformed into a branch research institute, apparently of the aircraft industry.⁴

Of primary interest here is the work of Gastev and other TsIT workers, notably N.M.Bakhrakh, on machine tool design and construction. Bakhrakh was deputy director of the Institute and chief engineer of 'Ustanovka' and in the 'thirties headed work on unit-construction machine tool building. Gastev's interest in machine tool building arose out of his work on NOT. He first put forward his radical ideas in 1930 in the Institute's journal, Organizatsiya Truda.⁵ His startingpoint was a conviction that machine building as practised in both the capitalist countries and the USSR was in many respects irrational from the

1. Biographical details from TsIT i ego metody NOT, M., 1970, pp.3-16.

2. Some of the activities of TsIT are described in Friedmann, G., Problèmes du Machinisme en URSS et dans les pays capitalistes, Paris, 1934.

technical and economic points of view. The social and economic conditions of capitalism had, in Gastev's opinion, placed serious limitations on machine design and production. Machine tools tended to be conceived as closed units rather than as components of production systems; they tended to be built by small scale, craft methods, and their design was influenced strongly by such factors as secrecy, company and national pride, technical 'style', tradition and convention. In order to successfully develop mass production in the conditions of the socialist planned economy it was essential, Gastev believed, to subject capitalist machine design and production to radical review and create new forms appropriate to the conditions of proletarian power.⁶

The starting point and focus of socialist machine building, in Gastev's view, had to be the stage of assembly (montazh); the aim had to be the achievement of the most rapid possible construction of machine tools specific to each operation, and ease of assembly had to determine the design and previous stages of production. All machines, he considered, could be broken down into a relatively small number of constituent primary functional elements, e.g. units of rotation, units of forward and backward motion, speed change units, motor units, etc. This provided the possibility of building machine tools using the principle of agregatirovanie, defined by Bakharakh in 1937 as "...the making and assembling of machine tools of various purposes from separate standard units or mechanisms which are common to all machine tools, or for the given machine tool, with additional special units and fixtures depending on the purpose of the machine".⁷ The units themselves were to be built from standardised components and because many of them would be common to a wide range of machines it was believed that their large-serial or mass production at specialised factories would be possible. The actual machine tools could then be assembled either at special machine tool assembly works, or, preferably, at machine building enterprises, which would build up machines when required for specific purposes. It was believed that the rigorous pursuit of the unit construction principle would render the conventional classification by types of machine, e.g. lathe, drilling, milling machine, etc. obsolete,

3. Nauchno-issledovatel'skii institut tyazheloi promyshlennosti, M., 1935, pp. 927-928.

4. TsIT i ego metody NOT, op cit, p. 54.

5. Organizatsiya truda, 1930, No. 4; see Kak nado rabotat, M., 1972, pp. 443-449.

and also supersede the traditional 'universal', 'special' and 'specialised' categories. Gastev and his colleagues also advocated a revision of traditionally held views on the materials to be used in machine building; they believed that there was scope for the use of wood, simple angled girders, plastics (for gears, control buttons, etc.), and ferro-concrete, the latter for making machine tool beds at the place of installation rather than at the machine tool factory.⁸ Gastev pursued the idea of unit-construction machine tool building with a scientific rigour unknown in the West at the time, and with a unique comprehensiveness of approach and vision. And although the principle of unit-construction was not new and there was some similarity between Gastev's work and the ideas of Taylor⁹ he must be credited with an original contribution to the development of machine tool technology.

Gastev was not content with undertaking theoretical work alone, he also actively propagated his ideas for 'technical reconstruction' in order to influence policy in the engineering industry, and began to build machines based on the new principles. Early in May 1931 a VSNKh order appeared supporting the Institute's work and shortly after this the newspaper ZaIndustrializatsiyu devoted a whole page to Gastev's work under the title, 'For a revolution in machine building'. In October 1931 this direction of activity received high level backing when the Party Central Committee issued a decree approving the Institute's work.¹¹ It appears to have been after this decree that an experimental factory was created for building machine tools under the aegis of 'Ustanovka'. The experimental factory No.1 began work in 1932 building a small, simple lathe, the 'S-03' incorporating some of Gastev's ideas. This machine was to be widely used in training workshops in the 1930s. Over 300 machines were built in 1932 and nearly 500 in the following year.¹²

6. ibid.

7. Organizatsiya truda, 1937, No.10, p.19.

8. Ek.zhizn', 11.3.1932.

9. See above, p.227. Despite the similarity of ideas we have found no reference to Taylor's work in Gastev's writings.

10. ZaInd., 18.5.1931.

11. TsIT i ego metody NOT, op cit, p.125.

12. Stankostroitel'nyi zavod TsITA, M., 1934, p.19 & chart 8.

Despite some high level support - Gastev in 1935 noted that TsIT's activity had been backed by Ordzhonikidze, M. Kaganovich¹, and Al'perovich - there seems to have been quite wide scepticism about TsIT's work and its practical value. Bakhrakh, writing in 1937, acknowledged that there had been a large number of opponents to the work on unit-construction in the early years.² Furthermore, Gastev found it necessary to argue for the right to take ^{the} risks involved in the novel work of creating new machines.³ Nevertheless in October 1933 GUSIP issued an order supporting TsIT's work and calling for an expansion of its production of machine tools and standard units, and also proposed that the Institute draw up a project for a new factory for making standard units for low-powered machine tools.⁴ There may be a connection between this measure and the creation two years later of the factory of small unit-construction machine tools in Sverdlovsk, but virtually no reference to this work has been traced. It is known that this work was sited at what was originally to have been a heavy machine tool factory, which was projected then conserved, and that it built a small universal milling machine of a type suitable for toolrooms.⁵

The TsIT No.1 factory not only built machine tools (its range of unit-construction models widened from 1933), it also pioneered progressive new production organisation. This factory was the first Soviet machine tool works to switch (in 1933) from the traditional method of brigade assembly to flow assembly. Under the traditional system a brigade of workers built a complete machine and work was organised on a batch basis. Despite a quite small annual output of about 500 units a year in 1933, planned to rise to 100 units a month, the assembly process was broken down into a sequence of operations each of approximately the same length and machines passed from one operation to the next on special trolleys. Large units were assembled in the same way. The flow principle was also extended to machining operations, each of which was specified on a detailed job card.⁶ The flow assembly methods appear to have been very similar to those later introduced at the 'Krasnyi Proletarii' factory. TsIT workers also made a direct contribution

1. Kaganovich spoke in favour of TsIT's work at a meeting of NKTP's collegium in June 1932 - *ZaInd.*, 22.6.1932.

2. *Organizatsiya truda*, 1937, No. 10, p. 19.

3. *ZaInd.*, 22.6.1932; *Organizatsiya truda*, 1935, no. 6, p. 3.

4. *Stankostroitel'nyi zavod TsIT*, op cit, p. 14.

to the work of the machine tool industry at the Im.Ordzhonikidze factory. A brigade of TsIT workers helped to develop progressive work organisation and methods at the factory in 1933 during the difficult period when it was assimilating production.⁷

Between 1932 and 1937 TsIT made over a thousand unit-construction machines on both a serial and one-off basis,⁸ with many special machines which were also developed by the experimental factory No.2 of the 'Ustanovka' trust. This factory undertook a range of special production activities^{les} including the production of pistons undertaken on a series of special unit-construction machines of TsIT design, some of which were linked by automatic transfer mechanisms.⁹ TsIT also created a very advanced flow line of unit-construction machines for making pistons at the Chelyabinsk tractor factory.¹⁰

In the course of the 1930s TsIT and its experimental factories appears to have devoted increasing attention to the aircraft industry and the rationalisation of technological processes of machining and assembly. Work was undertaken on the classification of components and the typification of processes, and also on the introduction of flow organisation into serial production.¹¹ From 1937 the No.2 factory was devoted to making means of mechanisation of labour intensive processes at aircraft factories, but machine tool production evidently continued, because in 1939 it was reported that this factory had mastered 36 types of machine tool during the year with widescale use of standard assemblies.¹² From the end of the Second Five-year Plan the Institute's work seems to have been channelled increasingly to serve the demands of the defence industries and both the Institute and 'Ustanovka' appear to have been transferred from NKTP to the defence industry commissariat at about this time. Part of its activity was concerned with the ammunition industry and later a special TsIT boepripasov was formed, which created flow lines, some of the semi-automatic type, for making ammunition. This experience is reported to have been widely used during the War.¹³

5. Aizenshtadt and Chikhachev, *op cit*, p.261.; *ZaInd.*, 14.5.1937.

6. *TsIT i ego metody NOT*, *op cit*, pp.121-123.; *Stankostroitel'nyi zavod TsIT*, *op cit*, pp.15-20.

7. See Losev, A.G., *Organizatsiya truda v period osvoeniya*, M., 1933.

8. *Organizatsiya truda*, 1937, No.10, p.19. This total may exclude the 'S-03' lathe which was not a proper unit-construction machine, although the basic product of factory No.1.

On many occasions during the 'thirties Gastev propagated the benefits of the TsIT method of unit-construction. In 1935, when the 'official' machine tool industry began to take the unit-construction principle seriously he noted that the Institute had suddenly found that¹ it enjoyed wide support. But at the same time he expressed concern that the machine tool industry would take the easy way out and, instead of developing unit-construction in the rigorous way charted by TsIT, simply copy existing foreign models. This, he stressed, would not provide a basis for overtaking capitalist machine tool building.¹ Two years later Bakhrakh was complaining that this had happened; foreign machines were being copied.² In developing unit-construction machines the specialised machine tool industry did in effect by-pass TsIT and its pioneering work. In 1938 Gastev was still appealing for proper large-scale production facilities so that the building of complex unit-construction machines and flow lines could be put on a viable footing.³ The subsequent fate of TsIT's machine tool building within the defence industry is not known.

Although Gastev's original contribution of the 1930s had only limited impact at the time his ideas have not been forgotten. From about the late 1950s the unit-construction principle as evolved by TsIT has been propagated in the Soviet Union, notably by V.V.Boitsov.⁴ Furthermore, Gastev's works have been republished and a survey of the activities of the Institute has been produced,⁵ which stresses the contemporary relevance of Gastev's work on machine tool design. Thus TsIT made a lasting contribution. The work of ENIMS and the specialised industry was firmly anchored in the mainstream of world machine tool development; but Gastev, Bakhrakh and the other TsIT workers consciously strived to move forward and to raise machine tool building to a new higher level.

9. TsIT 1 ego metody NOT, op cit, pp.125-127.

10. *ibid.*, pp.260-265.

11. *ibid.*, 129-133.

12. Mashinostroenie, 31.12.1939.

13. TsIT 1 ego metody NOT, op cit, pp.127-129.

1. Organizatsiya truda, 1935, No.6, p.2.

2. *ibid.*, 1937, No.10, p.36.

3. Kak nado rabotat', op cit, p.455.

4. See Pravda, 7.8.1958.; Boitsov, V.V., Mekhanizatsiya i avtomatizatsiya v melkoseriinom i seriinom proizvodstvakh, 2nd.edn., M., 1971.

5. TsIT 1 ego metody NOT, op cit.

A Chronology of the Main Events in the Development of the Machine Tool Industry

1926	March 4th	Glavmetall decree on formation of a Section of Machine Tool Building attached to the Convention of Syndicates of the Metal Industry.
	May	Meeting of Glavmetall on machine tool building.
1927	March	Meeting of Glavmetall on the development of machine tool building in the Five-year Plan period.
1928	November	Meeting of machine tool building workers to discuss the development of the branch.
1929	January 25th	Presidium of VSNKh call for the organisation of a machine tool building trust.
	April	The development of the industry and the creation of a trust discussed by the Collegium of Glavmashstroi.
	April 29th	Sixteenth Party Conference approved the First Five-year Plan.
	May(1st week)	Glavmashstroi revised the Plan for the industry.
	May 19th	The findings of the NK RKI survey of machine tool building published.
	May 29th	STO approved the formation of Stankotrest
	July 31st	NK RKI decree on the rationalisation of machine tool building
	October 1st	Stankotrest began operation.
1930	January 11th	VSNKh Presidium decree , 'On the state of machine tool building and measures for its further development!
	April 2nd	STO approved formation of Soyuzstankoinstrument ob"edinenie.
	June	Construction of Gor'kii milling machine factory began.
	June	Soyuzstankoinstrument began operation.
	July	Construction of Moscow turret lathe factory began.
	September (11th?)	Presidium of VSNKh discussed the state of the industry.
	September (16th?)	VSNKh Presidium decree on machine tool building.
1931	January 10-13th	All-Union production meeting on machine tool building.
	May 3rd	VSNKh Presidium approved organisation of NIISTI.
	July 16th	SNK USSR decree on the creation of Stankoob"edinenie.
	November	The Central Design Bureau created.
	December 25th	Basic construction of turret lathe factory completed.
	December 29th	Basic construction of the Gor'kii factory completed.
	December	Stankoob"edinenie began operation.

1932	March	'Court' on the 'DIP' lathe.
	April 5th	Meeting of Collegium of NKTP on the machine tool industry and the assimilation of new models.
	June 1st	NKTP Order No.407, 'On the further development of the machine tool industry'.
	July 14-17th	First Conference of Machine Tool Designers.
1933	February 24th	NKTP Order No. 173 forbidding the import of certain types of machinery.
	March 22-23rd	Production-technical conference of machine tool building.
	May 19th	NKTP Order on the organisation of ENIMS.
	June 16th	NKTP Order No.557 'On the development of machine tool building'.
	June 20-22nd	First All-Union Conference on Machine Tool Building.
	August 31st	SNK decree on the creation of GUSIP.
1934	January 23rd	NKTP Order No.141, 'On the plan of development of machine tool building and the production of metal forming equipment in the Second Five-year Plan'.
	January/February	First Machine Tool Exhibition.
	February 10th	Seventeenth Party Congress adopted resolution on the Second Five-year Plan.
	March 25th	NKTP Order No.430 calling for an improvement in the work of the im.Ordzhonikidze and Gor'kii factories.
	November	Leaders of the machine tool industry visited the London machine tool exhibition at Olympia.
	December 30th	NKTP Order on equipping the auto-tractor factories with Soviet machine tools.
1935	January	M.Kaganovich report on the industry and technical progress at Seventh Congress of Soviets.
	January/February	Second Machine Tool Exhibition.
	March 20-22nd	Third Conference of Machine Tool Designers.
	April	All-Union conference of machine tool factory workers.
	July 11-13th	Party-technical conference of GUSIP.
1936	February 13-17th	Branch conference of enterprises of GUSIP.
	April 7-8th	Fourth Conference of Machine Tool Designers.
1937	March?	First Conference of Machine Tool Building Production Engineers.
	July 3rd	E.Levin removed as director of ENIMS and 'Stankokonstruktziya'.
	July/August?	E.M.Al'perovich removed as leader of GUSIP.

- 1938 January Third Machine Tool Exhibition.
- 1939 February Conference of chief engineers and technicians of machine tool building factories.
- March 21st Eighteenth Party Congress adopted resolution on the Third Five-year Plan.
- September 4th SNK decree, 'On the development of the machine tool building industry in the USSR'.
- September Creation of Glavtyazhstankoprom and Glavstankoprom. ENIMS transferred to NKTyazhMash.
- 1940 April Fifth Conference of Machine Tool Designers.
- September/October All-Union meeting of machine tool builders.
- December 8th Decree of Central Committee VKP(b) and SNK USSR, 'On the development of machine tool building in the USSR'.
- 1941 June 5th Government decree on the creation of the People's Commissariat of Machine Tool Building.
- SA.I Output of machine tool building industry, 1928-1937.
- SA.II The Structure of Machine Tool Building Industry, 1928-1937.
- SA.III Plans and Programs of Machine Tool Building Industry, 1938-1940.
- SA.IV The Growth of Machine Tool Building Industry, 1928-1937.
- SA.V The Age of Machine Tool Building Industry, 1928-1937.
- SA.VI The Structure of Machine Tool Building Industry, 1928-1937.
- SA.VII The Structure of Machine Tool Building Industry, 1928-1937.
- SA.VIII The Structure of Machine Tool Building Industry, 1928-1937.
- SA.IX The Structure of Machine Tool Building Industry, 1928-1937.
- SA.X The Structure of Machine Tool Building Industry, 1928-1937.
- SA.XI The Structure of Machine Tool Building Industry, 1928-1937.
- SA.XII The Structure of Machine Tool Building Industry, 1928-1937.
- SA.XIII The Structure of Machine Tool Building Industry, 1928-1937.
- SA.XIV The Structure of Machine Tool Building Industry, 1928-1937.
- SA.XV The Structure of Machine Tool Building Industry, 1928-1937.
- SA.XVI Soviet Machine Tool Imports, 1928-1937.
- SA.XVII Machine Tool Imports as a Percentage of All Imports and Exports, 1928-1937.
- SA.XVIII The Level of Import Dependence, 1928-1937.
- SA.XIX Import Dependence by Type of Machine Tool, 1928-1937.
- SA.XX The Structure of Machine Tool Imports by Country of Origin, 1928-1937.
- SA.XXI The Structure of Machine Tool Imports by Type of Machine, 1928-1937.
- SA.XXII The Structure of Imported Machine Tools, 1928-1937.
- SA.XXIII The Structure of Imported and Soviet-Built Machine Tools Installed in the Machine Building and Metal Working Industries, 1928-1937.
- SA.XXIV Indicators of the Technical Level of Imported and Soviet-Built Machine Tools Installed in the Machine Building Industry, 1928-1937.
- SA.XXV Soviet Machine Tool Exports, 1928-1937.
- SA.XXVI Imported Machine Tools Installed in the Engineering Industry during the First Five-year Plan, and the Degree of Specialization and Automation of Installed Machines.
- SA.XXVII The Product Capacity of Machine Tool Enterprises, 1928-1937.
- SA.XXVIII The Construction of New Machine Tool Factories - Plans and Achievement, 1928-1937.
- SA.XXIX The Prices and Costs of New Machine Tools, 1928-1937.
- SA.XXX The Performance of Three Leading Enterprises - "Travnik", "Proletarii", "Gorkh" machine tool factory and an Enterprise.

STATISTICAL APPENDIX

Table SA.I	Output of Machine Tools in Physical Terms.
Table SA.II	Output of Machine Tools in Value Terms.
Table SA.III	Planned and Actual Output of Major Factories.
Table SA.IV	The Geographical Distribution of Machine Tool Production.
Table SA.V	The Growth of the Machine Tool Stock.
Table SA.VI	The Age of the Machine Tool Stock in 1940.
Table SA.VII	The Structure of Total Machine Tool Output by Type of Machine(units).
Table SA.VIII	The Structure of Total Machine Tool Output by Type (per cent).
Table SA.IX	The Output of the Specialised Machine Tool Industry by Type (units).
Table SA.X	The Output of the Specialised Machine Tool Industry by Type(per cent).
Table SA.XI	The Number of Types and Sizes of Machine Tools in Production.
Table SA.XII	The Number of New Types and Sizes Built.
Table SA.XIII	The Transition from Old to New Models, 1928/29 - 1933.
Table SA.XIV	The Year of First Soviet Production of the Main Types of Machine Tool.
Table SA.XV	Origin of the Main Types of Machine Tools built in the USSR.
Table SA.XVI	Soviet Metal-cutting Machine Tool Imports, 1913- 1940.
Table SA.XVII	Machine Tool Imports as a Proportion of all Machinery and Equipment Imports and Total Imports.
Table SA.XVIII	The Level of Import Dependence.
Table SA.XIX	Import Dependence by Type of Machine Tool, 1936-37.
Table SA.XX	The Structure of Machine Tool Imports by Country of Origin.
Table SA.XXI	The Structure of Machine Tool Imports by Type of Machine,1929-1938.
Table SA.XXII	The Structure of Imported Lathes.
Table SA.XXIII	The Structure of Imported and Soviet-built Machine Tools Installed in the Machine Building and Metal Working Industries, 1928-1933.
Table SA.XXIV	Indicators of the Technical Level of Imported and Soviet-built Machine Tools Installed in the Machine Building Industry,1928-1932.
Table SA.XXV	Soviet Machine Tool Exports, 1934-1940.
Table SA.XXVI	Imported Machine Tools,Installations in the Engineering Industry during the First Five-year Plan, and the Degree of Specialisation and Automation of Installed Machines.
Table SA.XXVII	The Project Capacity of Machine Tool Enterprises.
Table SA.XXVIII	The Construction of New Machine Tool Factories - Plans and Achievement, 1929-1941.
Table SA.XXIX	The Prices and Costs of Some Basic Models, 1932-1940.
Table SA.XXX	The Performance of Three Leading Enterprises - 'Krasnyi Proletarii', Gor'kii milling machine factory and im.Ordzhonikidze.

Table SA.I

OUTPUT OF MACHINE TOOLS

First Five-year Plan, 1928/29 - 1932

(units)

	1928/29	1929/30	Special Quarter	1931	1932
A. Specialised machine tool industry:					
Planned Output.....				10926 ¹	10833 ²
Actual Output.....	2560 ^{3(a)}	4843 ³	1603 ³	8963 ³	7311 ³
Fulfilment of Plan(%)				82.0	67.5
B. 'Planned' factories:					
Planned Output.....				11074 ⁴	11167 ⁴
Actual Output.....	1238 ⁴	2119 ⁴	892 ³	7695 ⁴	10355 ⁴
Fulfilment of Plan(%)				69.5	92.7
C. Total specialised and 'planned' output:					
Planned Output.....				22000 ⁵	22000 ²
Actual Output.....	3798 ⁶	7062 ⁶	2500 ³	16658 ⁶	17666 ⁶
Fulfilment of Plan(%)				75.7	80.3
D. Output of simple machine tools*					
Planned Output.....				1659 ⁶	2054 ⁶
Actual Output.....	459 ⁶	935 ⁶			
E. Total Output:					
Planned Output.....					
Actual Output.....	4257 ⁶	7997 ⁶		18317 ⁶	19720 ⁶

*simple polishing and sharpening machines

Sources and notes - see p. 535.

Table SA.I cont.

OUTPUT OF MACHINE TOOLS

Second Five-Year Plan, 1933 - 1937

(units)

	1933	1934	1935	1936	1937
A. Specialised Machine Tool Industry:					
Planned Output.....	8282 ¹	8852 ²	11127 ³	14000 ⁴	19900 ⁵
Actual Output.....	7838 ⁴	8304 ⁴	10100 ⁶	13288 ⁶	15785 ⁶
Fulfilment of Plan (%)	94.6	93.8	90.8	94.9	79.3
B. Total NKTP Output:					
Planned Output.....		19000 ^{6a}	19800 ⁷	23905 ⁸	30000 ⁹
Actual Output.....	15400 ^{6a}	15900 ⁷	19378 ⁹	23624 ⁹	
Fulfilment of Plan (%)			97.9	98.8	
C. 'Planned' factories:					
Planned Output.....	11383 ¹⁰		15000 ¹⁰	18405 ¹⁰	21116 ¹⁰
Actual Output.....	10663 ¹⁰	12827 ¹⁰	14772 ¹⁰	19120 ¹⁰	20335 ¹⁰
Fulfilment of Plan (%)	93.7		98.5	103.9	96.3
including:					
a) NKTP, other than the specialised industry:					
Planned Output.....		10148 ¹¹	8673 ¹¹	9905 ¹¹	10100 ¹¹
Actual Output.....	7562 ¹¹	7596 ¹¹	9278 ¹¹	10336 ¹¹	
Fulfilment of Plan (%)		74.9	107.0	104.4	
including:					
Defence Industry:					
Planned Output.....		4965 ¹²	7634 ¹³		
b) Other 'Planned' Prod'n*					
Planned Output.....			6327 ¹⁴	8500 ¹⁴ (a)	11116 ¹⁴ (a)
Actual Output.....	3101 ¹⁴	5231 ¹⁴	5494 ¹⁴	8784 ¹⁴	
Fulfilment of Plan (%)			86.2	103.3	
D. Total Specialised and 'Planned' Output:					
Planned Output.....	19665 ¹⁵	(b)	26127 ⁴	32405 ⁸	41016 ⁹
Actual Output.....	18501 ¹⁶	21131 ¹⁶	24872 ⁹	32408 ⁹	36120 ¹⁷
Fulfilment of Plan (%)	94.1		95.2	100.0	88.1
E. Output of Simple Machine Tools:†					
Planned Output.....				(c)	
Actual Output	2497 ¹⁸	4296 ¹⁸	9028 ¹⁸	11992 ¹⁸	12353 ¹⁸
F. Total Output					
Planned Output.....					
Actual Output.....	20998 ¹⁹	25400 ²⁰	33900 ²⁰	44400 ²⁰	48473 ²¹

*NKMeStFrom; NKVD; NKProRSFSR, etc.

†including simple polishing and sharpening machines and the products of FromCooperatives, NKZem., NKPS-repair factories, etc.

Sources and notes - see p.535.

Table SA.1 cont.

OUTPUT OF MACHINE TOOLS

Third Five-Year Plan, 1938 - 1941

	1938	1939	1940	1941
A. Specialised Machine Tool Industry*				
Planned Output.....	20000 ¹	27795 ²	32000 ³	35000 ⁴
Actual Output.....	19830 ⁵	25030 ⁵	27754 ⁶	24572 ⁵
Fulfilment of Plan(%)	99.2	90.1 ^(a)	86.7	70.2
B. Defence Industry:				
Planned Output..... including:		8865 ³	10800 ³	11900 ⁴
NKV.....		4426 ³	5200 ³	5200 ⁴
NKB.....		2217 ³	2900 ³	3200 ⁴
NKAP.....		2222 ³	2700 ³	3500 ⁴
C. Production of Other NKs:				
Planned Output..... including:		7755 ⁷	7500 ⁷	11100 ⁷
NKMestProm.....		3185 ²	3300 ³	1100 ⁴
NKZem.....		2010 ²		1700 ⁴
NKVD.....		1330 ²		
D. Total Output of Specialised Ind., Defence Industry and Other NKs:				
Planned Output.....		44415 ³	51300 ³	58000 ⁴
Actual Output.....	40170 ⁸	40900 ⁹	42500 ⁹	
Fulfilment of Plan (%)		92.1	82.8	
E. Output of Simple Machine Tools⁺:				
Actual Output.....	15330 ¹⁰	14135 ¹⁰	15973 ¹⁰	
F. Total Output				
Planned Output.....				
Actual Output.....	55500 ¹¹	55035 ¹²	584 ³⁷ 12	44510 ¹² (inc. 1st half: 13 28100) ¹³

*1938 Glavstankoinstrument ; 1939-41 NKTyazhMash.

⁺ including simple polishing and sharpening machines and the products of PromCooperatives, repair factories of NKPS, etc.

Sources and notes - see p. 535.

Table SA.1 cont.

RATE OF GROWTH OF MACHINE TOOL OUTPUT

Index:- Previous year = 100;

	1929/30	1931	1932	1933	1934	1935
a) Specialised ind.	190.7	185.1	81.6	107.2	105.9	121.6
b) Splsd. plus 'planned'.	185.9	235.9	106.1	102.1	114.4	117.7
c) Total output	187.9	229.0	107.7	106.5	121.0	133.5
	1936	1937	1938	1939	1940	1941
a)	131.6	118.8	125.6	126.2	110.9	88.5
b)	130.3	111.5	111.2	101.8	103.9	
c)	131.0	109.2	111.4	99.2	106.2	76.1

Indices of Growth of Output during Five-year Plans:First Five-Year Plan

	1928/29	1929/30	1931	1932
a) Specialised industry	100	190.7	350.1	285.6
b) Splsd. plus 'planned'	100	185.9	438.6	465.1
c) Total Output	100	187.9	430.3	463.2

Second Five-Year Plan

	1933	1934	1935	1936	1937
a) Specialised industry	100	105.9	128.9	169.5	201.4
b) Splsd. plus 'planned'	100	114.2	134.4	175.2	195.2
c) Total Output	100	121.0	161.4	211.4	230.8

Third Five-Year Plan

	1938	1939	1940	1941
a) Specialised industry	100	126.2	140.0	123.9
b) Splsd. plus 'planned'	100	101.8	105.8	
c) Total Output	100	99.2	105.4	80.2

Index of Growth of Output, 1928/29 - 1941 (1933=100)

Index of Growth of Output, 1928/29 - 1941 (1922=100)							
	1928/29	1929/30	1931	1932	1933	1934	
a) Specialised industry	32.7	61.8	114.4	93.3	100	105.9	
b) Splsd. plus 'planned'	20.5	38.2	90.0	95.5	100	114.2	
c) Total Output	20.3	38.1	87.2	93.9	100	121.0	
	1935	1936	1937	1938	1939	1940	1941
a)	128.9	169.5	201.4	253.3	320.0	353.0	313.5
b)	134.4	175.2	195.2	217.1	221.1	229.7	
c)	161.4	211.4	230.8	264.3	262.1	278.5	212.1

Source: see next page.

Source Table SA.1:First Five-year Plan

1. Ek.zhizn, supplement on 'annual balances', 1931, No 11, Aug..
2. SiI, 1932, No 4, p2.
3. Prob.Ek., 1935, No 4, p194.
4. By subtraction, C-A.
5. ZaInd., 14-4-31.
6. Sotsialisticheskoe stroitel'stvo SSSR, M., 1934, p48.

Notes

- (a) Output of factories under Stankoob"edinenie in 1930.

Second Five-year Plan

1. Prob.Ek., 1935, No 4, p199.
2. SiI, 1934, No 4, p1 (includes 200 for tooling factories of GUSIP)
3. Prob.Ek., 1935, No 4, p193 (includes 570 for tooling factories of GUSIP)
4. Prob.Ek., 1935, No 4, p200
6. Calculated from the index of output of specialised industry (Zhed', op cit, p13) on the basis of the known output for 1933, '34 and 1940. Approximate.
5. ZaInd., 12-8-37. ; 6a. Proekt vtorogo pyatiletnego plana..., op cit, Vol. 1, p. 450.
7. Narodnokhozyaistvennyi plan na 1936g., p417.
8. PlanKhoz, 1937, No 3, p230.
9. Narodno-khozyaistvennyi plan Soyuza SSR na 1937g., p72.
10. By subtraction, D-A.
11. By subtraction, B-A.
12. SiI, 1934, No 3, p1 (as residual).
13. ZaInd., 26-10-35.
14. By subtraction, D-B.
15. ZaInd., 23-6-33.
16. Sotsialisticheskoe stroitel'stvo SSSR, M., 1936, p156 (incorrect total for 1933 amended)
17. Tretii pyatiletnii plan razvitiya narodnogo khozyaistva Soyuza SSR, p207.
18. By subtraction, F-D.
19. Pen'kov, P.M., Razvitie tipazha..., p9.
20. Narkhoz SSSR v 1958g., p231.
21. Promyshlennost' SSSR, 1956, p208.

Notes

- (a) Including local industry (NKMP) 7000 (ZaInd, 12-5-37)
- (b) Plan 19000 'without sharpening machines'. According to this definition output in 1932 was 15,000 units and in 1933 15,400 units. This definition was adopted for the Second Five-Year Plan, 1934. (Narkhoz. plan na 1935g., p 516; Proekt vtorogo pyatiletnego plan razvitiya narodnogo khozyaistva SSSR, T.1, p430)
- (c) Including 2,000 for NKZem. (PlanKhoz, 1936, No 2, p264)
- (d) Including local industry (NKMP) 6200 (Narkhoz. plan na 1936g., p478)

Third Five-year Plan

1. Trudy Leningradskoi konferentsii po tipizatsii tekhnologicheskikh protsessov, L-M., 1940, p49.
2. Gosudarstvennyi plan razvitiya narodnogo khozyaistva SSSR v 1939g., p23.
3. Direktivy KPSS i sovetskogo pravitel'stva po khozyaistvennym voprosam, Vol. 2, p. 602.
4. Gosudarstvennyi plan razvitiya narodnogo khozyaistva SSSR na 1941g., p32
5. As 6 (Second Five-year Plan), above.
6. Oboznyi, A.G., Osnovnye fondy mashinostroeniya i puti uluchsheniya ikh ispol'zovaniya, Kiev, 1962, p15.
7. By subtraction, D-(A+B).
8. As 2, p4. (provisional output)

Source Table SA.1 cont.:Third Five-year Plan, cont.

9. Industrializatsiya SSSR, 1938-1941gg, M., 1973, pp129-130. (1940 - provisional).
 10. By subtraction, F-D.
 11. Narkhoz. SSSR v 1958g, p231.
 12. Penkov, P.M., Razvitie tipazha..., p9.
 13. Kravchenko, G., Ekonomika SSSR v otechestvennoi voyny, 1941-1945gg, M., 1970, 2nd edn., p168.

Notes

- (a) Kas'yanenko, V.I., Zavoevanie ekonomicheskoi nezavisimosti SSSR, M., 1972, p198 gives NKTyazhMash plan fulfilment as 84.7 per cent, i.e. an actual output of 23,542 units.

1931	15.5	1.0
1932	32.8	2.0
1933	47.4	3.0
1934	61.4	4.0
1935	(90.0)	5.0
1936	(128.0)	6.0
1937	139.0	7.0

Index of Growth of OutputFirst Five-year Plan

1928/29 = 100

Previous year = 100

Second Five-year Plan

1933 = 100

Previous year = 100

Index of Per Unit Values

1933 = 100

Specialised industry

Total output

45

50

45

50

50

50

50

50

50

50

50

50

50

50

50

50

50

50

Table SA.II

Output of Machine Tools In Value Terms, 1928/29 - 1937

(million rubles, 1926/27 prices)

Year	Specialised Industry		'Planned' Factories		Total Output	
	Marketed Output	Per unit value(r.)	Marketed Output	Per unit value(r.)	Marketed Output	Per unit value(r.)
1928/29	7.0	2,734	3.4	2,746	10.4	2,738
1929/30	14.0	2,891	6.0	2,832	20.0	2,832
1930 Sp.Q	4.5	2,798	2.1	2,354	6.6	2,640
1931	18.5	2,064	15.2	1,975	33.7	2,023
1932	32.8	4,436	46.8	4,520	79.6	4,506
1933	47.4	6,047	54.8	5,139	102.2	5,524
1934	66.0	7,984	58.2	4,537	124.2	5,878
1935	(90.0)	(8,910)	} not available			
1936	(126.0)	(9,482)				
1937	159.4	10,098				

Index of Growth of Output of the Specialised Industry

First Five-year Plan

	1929/30	1931	1932
1928/29 = 100	200.0	264.3	468.6
Previous year = 100	200.0	132.1	177.3

Second Five-year Plan

	1933	1934	1935	1936	1937
1933 = 100	100.0	139.2	201.2	274.4	486.0
Previous year = 100	144.5	139.2	136.4	140.0	126.5

Index of Per Unit Value

	1928/29	1929/30	1931	1932	1933	1934	1935	1936	1937
1933 = 100					100	131	148	157	167
Specialised industry	45	48	34	74	100	106			
Total output	50	51	37	82	100				

Source:

1928/29 - 1934 : *Problemy ekonomiki*, 1935, No.4, pp.194 and 200; except 1928/29 planned output - *ZaInd.*, 23.6.33. (*Prob.ek.*, loc.cit., gives 7.7m.r. which is considered too high and inconsistent with other sources).

1935 - 1936 : Estimates, on the basis of interpolation between 1934 and 1937.

1937 : From 486 per cent increase, 1932-37 - Aizenshtadt and Chikhachev, p214

Table SA.III

Planned and Actual Output of Major Factories1.1928-29 - 1932

(units)

Factory		1928-29	1929-30	1930SpQ	1931	1932
'Krasnyi Proletarii'	P.				1,810	2,857
	A.	609	1,249		2,190	2,378
im.Sverdlova	P.	400	700	190	1,210	585
	A.	299	524	292	605	474
im.Lenina	P.		1,115		3,320	2,217
	A.	303	1,487	638	3,459	2,203
im.Ordzhonikidze	P.	-	-	-	-	250
	A.	-	-	-	-	36
Gor'kii	P.	-	-	-	-	300
	A.	-	-	-	-	28
Khar'kov	P.	-	-	-	-	-
	A.	-	-	-	-	-
'Samotochka'	P.				760	1,057
	A.	155	343	155	758	743
im.TsK Mash.	P.				1,600	2,000
	A.	579	984	375	1,485	
'Komsomolets'	P.				350	540
	A.	107	262	84	465	
Izhevsk	P.					1,000
	A.					1,130
Tula	P.					
	A.					

P: Annual Plan.

A: Actual Output

- factories not in operation

Table SA.III cont.

Planned and Actual Output of Major Factories2. 1933 - 1940

(units)

Factory		1933	1934	1935	1936	1937	1938	1939	1940
'K.P.'	P.		2,390	2,716		2,903	(3,400)		
	A.	2,200	2,640		2,756	(2,900)	(3,625)		
im.Sv.	P.		310	300	450		655		
	A.					524			
im.L.	P.		1,695	1,800	1,920		(2,400)		
	A.	1,666							3,064
im.Ord.	P.	506	920	1,101	1,554				
	A.	466	608	1,301					
Gor'kii	P.	475	965	1,200	1,560	2,200			
	A.	418	548	1,181		1,887	2,511		
Khar'kov	P.		114	350	500		1,250		
	A.	4	31	182	509	721	1,129	1,338	1,750
'S.'	P.		800	891	790	(850)			
	A.	785							2,094
Im.TsK.M.	P.		537	692	811				
	A.								
'Kom.'	P.	383	325	422	320				
	A.	417							
Izhevsk	P.	1,200		(1,550)					
	A.	(1,400)				2,212			1,441
Tula	P.		1,250						
	A.	940							

(..) estimate

Table SA.III

Sources:'Krasnyi Proletarii'

- 1928-29A, 1929-30A - Lebyachenko, p.8.
 1931P - Metall, 1931, No.1, p.88.
 1931A - Lebyachenko, p.49.
 1932P - Sokolov, 1932, p.16.
 1933A - Industrial'noe razvitie tsentral'nogo promyshlennogo raiona, 1969, p.461.
 1934P - SiI, 1934, No.3, p.1 : 1934A - Vestnik metalloprom., 1935, No.9, p.113.
 1935P - Problemy ekonomiki, 1935, No.4, p.193.
 1936A - Slavnye traditsii, p.126.
 1937P - ZaInd., 6.1.37.
 1937A - Estimated from Slavnye traditsii, p.126.
 1938P&A - Estimated from Mashinostroenie, 2.10.39.

Im.Sverdlova

- 1928-29A, 1929-30A, 1930SQA, 1931A, 1932A - Borisov & Vasil'ev, p.132.
 1928-29P, 1929-30P - ZaInd., 15.2.30.
 1930SQP - Borisov & Vasil'ev, p.127.
 1931P - Metall, 1931, No.1, p.88.
 1932P - Sokolov, p.16.
 1934P - SiI, 1934, No.3, p.1.
 1935P - ZaInd., 14.4.35.
 1936P - ibid., 28.5.36.
 1937A, 1938P - Borisov & Vasil'ev, p.176.

Im.Lenina

- 1928-29A, 1929-30A, 1930SQA, 1931A, 1932A - Aizenshtat & Chikhachev, p.181.
 1931P - Metall, 1931, No.1, p.88.
 1932P - Sokolov, p.16.
 1934P - SiI, 1934, No.3, p.1.
 1935P - ZaInd., 12.7.35.
 1936P - ZaInd., 28.5.36.
 1938P - Estimated from SiI., 1938, No.9, p.42.
 1940A - Oboznyi, 1962, p.17.
 1929-30P - Nashi Dostizheniya, 1931, No.1, p.30.

Im.Ordzhonikidze

- 1932P - Sokolov, p.16.
 1932A, 1933A, 1934A - Tyazhelaya promyshlennost' SSSR za 1931-34gg., p.88.
 1933P - ZaInd., 15.3.34.
 1934P - ZaInd., 15.3.34.
 1935P - ZaInd., 12.7.35.
 1935A - ZaInd., 8.1.36.
 1936P - ZaInd., 28.5.36.

Gor'kii

- 1932P - Sokolov, p.16.
 1932A, 1933A, 1934A - Tyazh.prom. SSSR za 1931-34gg., p.88.
 1933P, 1934P - Predpriyatie, 1934, No.19, p.7.
 1935P - ZaInd., 12.7.35.
 1935A - Istoriya industrializatsii nizhegorodskogo-gor'kovskogo kraya, 1968, p.390.
 1936P - ZaInd., 28.5.36.
 1937P, 1937A - Istoriya..., pp.267 & 362.
 1938A - XVIII s"ezd VKP(b), p.391.

Khar'kov

- 1933A, 1935A, 1936A, 1937A, 1938A, 1939A, 1940A, 1934A, - Khar'kovskii stankostroitel'nyi, p.35.
 1934P - SI, 1934, No.3, p.1.
 1935P - ZaInd., 12.7.35.
 1936P - ZaInd., 28.5.36.
 1938P - Khar'kovskii stankostroitel'nyi, p.32.

Samotochka

- 1928-29A, 1929-30P, 1930SQA, 1931A - Lebyachenko, p.26.
 1931P - Metall, 1931, No.1, p.88.
 1932P - Sokolov, p.16.
 1932A - Moskovskii soviet rabochikh, krest'yanskikh i krasnarmeiskikh deputatov - otchet o rabote, 1931-34, M., n.d., p.29 (source gives '1933', but this is clearly a misprint)
 1934P - SI, 1934, No.3, p.1.
 1935P - Problemy ekonomiki, 1935, No.4, p.193.
 1936P - ZaInd., 2.9.36.
 1937P - estimated from ZaInd., 2.9.36.
 1940A - Gromov, V.I., Razvitie spetsializatsii i kooperirovaniya v promyshlennosti ekonomicheskogo raiona, M., 1963, p.30.

Im.TsK Mashinostroeniya

- 1928-29A, 1929-30A, 1930SQA, 1931A, 1932P - Lebyachenko, p.28.
 1931P - Metall, 1931, No.1, p.88.
 1934P - SI, 1934, No.3, p.1.
 1935P - Problemy ekonomiki, 1935, No.4, p.193.
 1936P - ZaInd., 28.5.36.

'Komsomolets'

- 1928-29A, 1929-30A, 1930SQA, 1931A - Lebyachenko, p.29.
 1931P - Metall, 1931, No.1, p.88.
 1932P - Sokolov, p.16.
 1933A, 1933P - SI, 1934, No.3, p.40. Pcalculated.
 1935P - Problemy ekonomiki, 1935, No.4, p.193.
 1936P - ZaInd., 28.5.36.

Izhevsk

- 1932P - Sokolov, p.16.
 1932A, 1933P, 1933A - Volkova & Perevalov, pp.19&34 (1933A estimated).
 1935P - ZaInd., 26.10.35, estimated from.
 1937A, 1940A - Narodnoe khozvaistvo Udmurtskoi ASSR, Izhevsk, 1957, p.22 (assumed to be the output of the Izhevsk factory only.).

Tula

- 1933P, 1934A - IV Moskovskaya oblastnaya i III gorodskaya konferentsiya VKP(b), 1934 p.75.

The Geographical Distribution of Machine Tool Production
(units)

Table SA.IV

Republic and Region	1913 ¹		1927-28		1932		1937		1940	
	No.	%	No.	%	No.	%	No.	%	No.	%
<u>R.S.F.S.R.</u>	1419	93.8	1187	60.0	13974	70.8	33860	69.9	39476	67.5
including by economic region:										
North-West	399	22.8	247	12.5	1492	7.5	4056	8.4	2553	4.4
Centre	1042	68.7	790	39.9	5830	29.6	17902	37.0	27167	46.5
(inc.Moscow obl.)	.	.	.	.	.	.	.	.	(8943)	(15.3)
Volga region	9	0.5	150	7.6	2556	13.0	4647	9.6	4404	7.5
Urals	29	1.8	-	-	2940	14.9	4190	8.6	2608	4.5
(inc.Udmurt ASSR)	.	.	.	.	.	.	(2212)	(4.6)	(1441)	(2.5)
North Caucasus	-	-	-	-	705	3.5	1187	2.4	1362	2.3
(inc.Krasnodar kr.)	.	.	.	.	(330)	(1.7)	(383)	(0.8)	(500)	(0.9)
Western Siberia	-	-	-	-	451	2.3	1878	3.9	1382	2.3
East Siberia & F.E.	-	-	-	-	-	-	-	-	-	-
<u>Ukrainian SSR</u>	65	4.3	791	40.0	5066	25.7	9125	19.7	11704	20.0
<u>Byelorussian SSR</u>	-	-	-	-	680	3.5	4441	9.2	5985	10.3
<u>Georgian SSR</u>	-	-	-	-	-	-	757	1.6	803	1.4
<u>Azerbaijdzhan SSR</u>	30	1.9	-	-	-	-	290	0.6	330	0.6
<u>Kirgizian SSR</u>	-	-	-	-	-	-	-	-	110	0.2
<u>Uzbek SSR</u>	-	-	-	-	-	-	-	-	29	-
<u>Other republics</u>	-	-	-	-	-	-	-	-	-	-
Total	1514	100.0	1978	100.0	19720	100.0	48473	100.0	58437	100.0

1. in the boundaries of the USSR prior to 1940.

- no production or insignificant.

. no data

Source:

Aizenshtadt and Chikhachev, op.cit., p.521, except:

Moscow oblast' - Moskovskaya oblast' za 50 let, M., 1967, p.47.

Udmurt ASSR - Narodnoe khozyaistvo Udmurtskoi ASSR, Izhevsk, 1957, p.22.

Krasnodar krai - Narodnoe khozyaistvo Krasnodarskogo kraya, Krasnodar, 1965, p.23.

Table SA.V

The Growth of the Machine Tool Stock
(number of units)

Year	All metal-cutting machine tools in the economy*	
	Series I	Series II
April 1932	181,403 ¹	
September 1934	242,266 ²	
January 1936	274,714 ³	
January 1938	380,000 ⁴	
November 1940		710,000 ⁵

* all existing machines, not necessarily installed.

Series I - based on census of metal-working equipment of April 1932; civilian branches only, excludes polishing and sharpening machines and other small and simple types.

Series II - result of census in November 1940; it is believed to include the defence industry stock, and also polishing machines and other simple types excluded from Series I.

Source:

1. Sotsialisticheskoe stroitel'stvo SSSR, 1935, p.70.

2. ibid., 1936, p.54.

3. Calculated from SSSR strana sotsializma, M., 1936, p.11.

4. Tretii pyatiletnii plan razvitiya narodnogo khozyaistva Soyuza SSR, M., 1939, p.20.

5. Narodnoe khozyaistvo SSSR v 1962 g., M., 1963, p.55.

Table SA.VI Age of the Machine Tool Stock in 1940

<u>Number of Units</u>	<u>Under 10 yrs.old</u>	<u>10-20 yrs.old</u>	<u>Over 20 yrs.old</u>
710,000	71 %	13 %	16 %

Source: Narodnoe khozyaistvo SSSR v 1962 g., M., 1963, p.55

The Structure of Total Machine Tool Output by Type of Machine , 1927/28 - 1941. (in terms of units)

Type of Machine Tool	1927/28	1928/29	1929/0	1931	1932	1933	1934	1935	1936+	1937	1940	1941P.
Lathes.....	830	1495	3295	7057	7115	7816	9076	x	x	15202	11523	13650
Turret Lathes.....	-	-	-	26	512	1049	1557	1919	1912	1806	2088	3370
Autos. & semi-autos..	-	-	-	-	-	-	120	283	725	894	2039	3136
Vertical drilling mcs	546	963	2167	6951	6838	5204	4950	x	x	12235	15251	x
Radial drilling mcs..	-	-	-	-	-	-	21	x	x	585	610	x
Milling mcs.....	53	205	189	730	1071	1581	1608	2076	2859	3243	3701	5147
Grinding mcs.....	3	75	155	530	254	619	1111	x	x	1839	2094	3501
Tool & cutter grg.mcs	15	-	-	-	221	-	-	-	-	2045	4268	x
Gear-cutting mcs.....	-	-	-	-	-	16	171	222	408	397	543	686
Planing mcs.....	146	162	256	145	223	65	111	x	x	303	173	300
Shaping mcs.....	35	235	377	747	835	968	1037	x	x	3172	2048	1300
Slotting mcs.....	35	5	35	11	46	89	100	x	x	250	158	200
Broaching mcs.....	-	-	-	-	-	-	-	-	10	44	68	350
Boring mcs.....	10	118	30	7	67	95	155	123	173	131	124	475
Combined mcs.....	-	-	-	1	30	132	167	x	x	(1)	(1)	120
Threading mcs.....	110	540	521	464	861	807	851	x	x	(2)	(2)	x
Special mcs.....	-	-	-	-	-	x	x	x	x	962	6688	8564
Other mcs.....	-	-	37	4	41	60	96	x	x	5365*	7061*	x
Total.....	1783	3798	7062	16675	18124	18501	21131	24872	32408	48473	58437	58000

- not built or insignificant quantity.

x no data.

(1) included in 'lathes'.

(2) included in 'other mcs.'.

* including a large proportion of polishing and sharpening machines not included in other years.

+ provisional output data.

Table SA.VII

Source:

- 1927/28-1934 - Sotsialisticheskoe stroitel'stvo SSSR, M., 1936, p156.
 Except: grinding mcs. and tool and cutter grinding mcs.
 in 1927/28 and 1932 - Narodnoe khoz'yaistvo SSSR v 1958 godu,
M., 1959, p232.; automatics and semi-autos. ,1934 - Narodno-
khos'yaistvennyi plan na 1936 god, M., 2nd edn., 1936, p417.;
 radial drilling mcs. - Table SA.IX.
- 1935 & 1936 - Narodno-khoz'yaistvennyi plan SSSR na 1937 god, M., 1937, pp72-73.
- 1937 & 1940 - Narodnoe khoz'yaistvo SSSR v 1958 godu, M., 1959, pp232-233.
- 1941 Plan - Gosudarstvennyi plan razvitiya narodnogo khoz'yaistva SSSR
na 1941 god., M., 1941, p.32.

The Structure of Total Machine Tool Output by Type of Machine, 1927/28 - 1941.

(as a percentage of total output)

Type of Machine tool	1927/28	1928/29	1929/30	1931	1932	1933	1934	1935	1936	1937	1940	1941P.
Lathes.....	46.6	39.3	46.7	42.3	39.3	42.2	43.0	x	x	31.4	19.7	23.5
Turret lathes.....	-	-	-	0.2	2.8	5.7	7.4	7.7	5.9	3.7	3.6	5.8
Autos. & semi-autos...	-	-	-	-	-	-	0.6	1.1	2.2	1.8	3.5	5.4
Vertical drilling mcs.	30.6	25.4	30.7	41.6	37.7	28.1	23.4	x	x	25.3	26.1	x
Radial drilling mcs...	-	-	-	-	-	-	0.1	x	x	1.2	1.0	x
Milling mcs.....	3.0	5.4	2.7	4.4	5.9	8.5	7.6	8.3	8.8	6.7	6.3	8.9
Grinding mcs.....	0.2	2.0	2.2	3.2	1.4	3.4	5.3	x	x	3.8	3.6	6.0
Tool & cutter grdg.mcs	0.8				1.2					4.2	7.3	x
Gear-cutting mcs.....	-	-	-	-	-	0.1	0.8	0.9	1.3	0.8	0.9	1.2
Planing mcs.....	8.2	4.3	3.6	0.9	1.2	0.4	0.5	x	x	0.6	0.3	0.5
Shaping mcs.....	1.9	6.2	5.3	4.4	4.6	5.2	4.9	x	x	6.5	3.5	7.5
Slotting mcs.....	1.9	0.1	0.5	0.1	0.3	0.5	0.4	x	x	0.5	0.3	0.3
Broaching mcs.....	-	-	-	-	-	-	-	-	0.03	0.1	0.1	0.6
Boring mcs.....	0.6	3.1	0.4	0.04	0.4	0.5	0.7	0.5	0.5	0.3	0.2	0.8
Combined mcs.....	-	-	-	-	0.2	0.7	0.8	x	x	(1)	(1)	0.2
Threading mcs.....	6.2	14.2	7.4	2.8	4.8	4.7	4.0	x	x	(2)	(2)	x
Special mcs.....	-	-	-	-	-	x	x	x	x	2.0	11.5	14.8
Other mcs.....	-	-	0.5	0.02	0.2	0.3	0.5	x	x	11.1	12.1	x
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	75.5

- not built or insignificant quantity.

(1) included in lathes.

(2) included in 'other mcs.'

x no data.

Source: calculated from Table SA.VII.

The Output of the Specialised Machine Tool Industry by Type of Machine . 1930 - 1940 (in terms of units)

(by type of machine, as a percentage of total output)

Type of Machine Tool	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
Lathes.....	2781	3760	4081	3760	3900	3470	4920	5245	5560	5532	6250
Turret lathes.....	-	-	46	510	624	1212	1501	1232	1710	1931	1720
Automatics & semi-autos..	-	-	-	-	76	151	325	456	556	1258	1207
Vertical drilling mcs...	1522	2577	1308	1206	964	817	1260	1880	2882	4034	3772
Radial drilling mcs.....	-	-	-	-	21	126	412	567	666	726	610
Milling machines.....	-	-	28	477	595	1261	1565	1922	2580	2634	2970
Grinding machines.....	-	-	-	-	104	220	451	900	1093	1367	1290
Gear-cutting machines...	-	-	-	16	178	172	298	393	657	751	543
Planing & Shaping mcs...	684	809	873	822	872	788	850	1099	1055	677	1625
Boring machines.....	-	7	67	95	104	121	173	131	129	138	124
Special machines.....	-	-	-	-	12	55	93	142	278	552	930
Other machines.....	536	503	908	952	854	1707	1432	1818	2564	5430	6443
Total.....	5523	8963	7311	7838	8304	10100	13280	15785	19830	25030	27754

Source: 1930-1932, based on Tsaguriya, M., Osvoenie novykh predpriyatii i novoi tekhniki v tyazheloi promyshlennosti, M-L., 1934, pl01. Total output for 1931 and 1932 from Problemy ekonomiki, 1935, No4, pl94.

1933-1940, calculated from data on the structure of output presented in Table SA.X, and from total output data of Table SA.I. Some items adjusted to conform with data of Table SA.VII.

Note: Output data presented above are approximate.

The Structure of Output of the Specialised Machine Tool Industry , 1930 - 1941.

(by type of machine , as a percentage of total output)

Type of Machine Tool	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Lathes.....	50.3	56.5	56.4	48.0	47.0	34.4	37.0	33.2	28.5	22.1	23.5	28.0
Turret lathes.....	-	-	0.5	6.4	7.5	12.0	11.3	7.8	8.6	7.7	6.2	7.0
Automatics & semi-autos.	-	-	-	-	0.9	1.5	2.45	2.9	2.8	5.1	4.35	5.2
Milling machines.....	-	-	0.4	6.07	7.15	12.5	11.8	12.2	13.0	10.5	10.7	12.0
Gear-cutting machines...	-	-	-	0.22	2.15	1.7	2.25	2.5	3.2	3.0	1.95	2.15
Boring machines.....	-	0.07	0.9	1.21	1.25	1.2	1.3	0.85	0.65	0.55	0.45	0.85
Planing and shaping mcs.	12.4	9.1	12.1	10.5	10.5	7.8	6.4	6.95	5.3	2.7	5.85	4.4
Grinding machines.....	-	-	-	-	1.25	2.0	3.4	5.7	5.5	5.45	4.65	6.8
Vertical drilling mcs...	27.6	28.8	17.8	15.4	11.6	8.1	9.5	11.9	14.5	16.1	13.6	6.1
Radial drilling mcs.....	-	-	-	-	0.25	1.25	3.1	3.6	3.35	2.9	2.2	2.5
Special machines.....	-	-	-	-	0.15	0.55	0.7	0.9	1.4	2.2	3.35	4.5
Other machines.....	9.7	5.5	11.9	12.2	10.3	15.0	10.8	11.5	13.2	21.7	23.2	20.5
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: 1930-1931 , calculated from Table SA.X.

1932-1941 , Zhed', M.S., Voprosy ekonomiki stankoinstrumental'noi promyshlennosti, M., 1946, p14.

Table SA.XI

The Growth of the 'Tipazh' - the Number of Types and Sizes
of Machine Tools in Production, 1932-1940

(end of year totals)

Year	Number of types and sizes produced ¹				
	Enterprises of:				Total: All mc. tool produced
	Specialised Industry	'Planned' Defence	Industry Other	Total S.+ 'P'	
	(1)	(2)	(3)	(4)	(5)
1932	26	14	13	53	
1933	38	14	25	77	80
1934	70	25	35	130	151
1935	90	32	43	165(155)	201
1936	112	25	48	185	220
1937	150	25	35	210(190)	250
1938	175	30	35	240	300
1939	230	35	40	305	380
1940	320	30	30	380(360)	500

1. Excludes all unit-construction machine tools built by 'Stankokonstruktsiya' and TsIT, and other special machines built on a one-off basis. These are included in (5).

(..) alternative total.

Source:

(1), (2), (3) and (4) - estimates based on data of catalogues, price lists and other sources. Basic sources:

1932 - Stanki, M., 1932; 1933, 34, 35 - Metallorezhushchie stanki proizvodstva zavodov SSSR, M-L., 1935; 1936-40 - Preiskuranty for 1936, 37, 38, 40-41.

Additional evidence:

- (1) 1932 - 26, Stennogrammy..., op cit, p.182; 1937 - 150-160, mid-1937, SiI, 1937 No.12, p.3; 1940 - 320, Penkov, P., Razvitie tipazha vypusk metallorezhushchikh stankov..., 1958, p.16.
- (4) 1935 - 155, ZaInd., 6.4.36; 1937 - 190, Planovoe khozyaistvo, 1938, No.9, p.42; 1940 - 360, Mekhanizatsiya i avtomatizatsiya proizvodstva, 1968, No.8, pp.21-22. Note - this source gives a total of 141 unit-construction and special types and sizes in 1940.
- (5) 1933, 34 - Prob.ek., 1935, No.4, p.203; 1935 - Plan, 1936, No.1, p.54; 1936 - est.; 1937 - est., supported by target of 250, as seen mid-1937, SiI, 1937, no.12, p.3; 1938 - Plan.khoz., 1938, No.9, p.38; 1939 - est. - 400 in Feb.1940, Mashinostroyeniye, 15.2.40; 1940 - Plan.khoz., 1944, No.2, p.30.

Table SA.XII

The Growth of the 'Tipazh' - the Number of New Types and Sizes Built,
1932 - 1940*

Year	Number of new types and sizes built in each year							
	Specialised Machine Tool Industry				'Planned' Enterprises		Total - all new types-sizes	
	Excluding unit-constrn. mc.ts. ¹		Including unit-constrn.mc.ts. ¹					
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
1932	15	8	15	8	.	.	.	.
1933	22	20	22	20	.	┌	.	┌
1934	49	42	49	42	.	└	.	└
1935	.	.	50-53	36	47-50	83	100	353 ²
1936	.	.	66	58	73	┌	139	┌
1937	125	78	164	114	.	└	.	└
1938	205	.	277	.	.	.	.	.
1939	155	78	207	130	.	.	.	.
1940	148	94	.	147	.	.	.	.

*Note - data should be treated with caution because during the period the building of a new type frequently meant just the making of a prototype, not the assimilation of serial production.

. not available.

- For 1938-40 types and sizes built by 'Stankokonstruktsiya' (mainly unit construction) were accounted separately.
- Including 222 at NKTP enterprises, 1933 - 1936. (ZaInd., 26.2.1937)

Source:

- 1932 - 15, SiI, 1932, No.2, p.2 ; 8, SiI, 1935, No.10, p.1.
 1933 - 22, SiI, 1934, No.4, p.1 ; 20, Aizenshtadt & Chikhachev, p.226.
 1934 - 49, SiI, 1934, No.4, p.3 ; 42, Aizenshtadt & Chikhachev, p.226.
 1935 - 50, SiI, 1935, No.1, p.6 ; 53, SiI, 1935, No.10, p.1 ; 36, Aizenshtadt & Chikhachev, p.226; 47-50, (Total less 50-53); 100, ZaInd., 26.3.36.
 1936 - 66, Plan, 1936, No.1, p.54; 58, Aizenshtadt & Chikhachev, p.226; 73, (Total less 66) 139, ZaInd., 6.4.36.
 1937 - 125, (164 less 39 u-c) Plan.Khoz., 1937, No.1, p.27; 78, (114 less 36 u-c), Granovskii, E., Avtomaticheskaya sistema mashin v promyshlennosti SSSR, M., 1939, p.256; 164, Plan.khoz., 1937, No.1, p.23; 114, Aizenshtadt & Chikhachev, p.226.
 1933-37 - 83, Aizenshtadt & Chikhachev, p.219; 353, (270 plus 83).
 1938 - 205, (277 less 72 u-c), Plan.khoz., 1938, No.5, p.22; 277, ibid.
 1939 - 155, Mashinostroenie, 18.1.40; 207, 155 plus 52 to be built by 'StSt.', Mashinostroiitel, 1939, No.1, p.4 ; 78, Mashinostroenie, 3.4.40; 130, Pravda, 21.2.41.
 1940 - 148, Kas'yanenko, V.I., Zavoevanie..., op cit, p.198; 94, ibid.; 147, Pravda, 21.2.41.

Table SA.XIII

THE TRANSITION FROM OLD TO NEW MODELS , 1928/29 - 1933

Main factories of Stankoob"edinenie

1. 'Krasnyi Proletarii'

Model	1928/29	1929/30	1931	1932	1933
Shaping mc.	x	x			
Threading mc.	x				
Planing mc.	x				
Slotting mc.	x				
Drilling mc.(SV-40)	x	x			
Lathe (TV-2)	x	x			
Lathe (TN-15)	x	x	x(1239)	x(1259)	x((350)
Lathe (TN-20)		x(127)	x(951)	x(1094)	x(1302)
Lathe (DIP-200)				■(25)	■(495+)
Lathe (DIP-300)					■(30+)
Gear-cutting mc.					■(2)
Multi-tool lathe(MT-30)					■(12)
Total number of models	7	5	2	3	6
inc. new models				1	4
Total annual output*	{609}	(1249)	(2190)	(2378)	((2200)

2. im.Sverdlova

Model	1928/29	1929/30	1931	1932	1933
Shaping mc.	x(29)	x(20)			
Drilling mc.(radial)	x(1)	x(16)			
Tool grinding mc.	x(32)	x(30)			
Slotting mc.		x(20)			
Grinding mc.('Fortuna')		■(43)			
Lathe (TV-25)	x(237)	x(394)	x(593)	x(399)	x
Horiz.boring mc.(R80)			■(7)	■(67)	■(87)
Planing mc.(3PS)				■(1)	■{28}
Planing mc.(2PS)					■
Threading mc for pipe couplings (911)					■(24)
Total number of models	4	6	2	3	5
inc. new models		1	1	2	4
Total annual output	(299)	(524)	(605)	(474)	

Table SA.XIII cont.

3. im.Lenina

Model	1928/29	1929/30	1931	1932	1933
Lathe (TV-220)	x(135)	x(325)	x(288)	x(4)	
Planing (PS)	x(26)	x(75)	x(131)	x(129)	x(27)
Threading mc.(old)	x(427)	x(266)	x(405)	x(484)	
Threading mc.(507)		■(10)	■(59)	■(379)	■(514)
Pipe threading mc.(912)					■(33)
Drilling mc.(13mm)	x ₁ (215)	x ₁ (811)	x		
Drilling mc.(65mm)	x	x	x(2571)	x ₁ (1241)	
Drilling mc.2spd.(18mm)			■	■	■(945)
Drilling mc.4spd.(18mm)				■(6)	■(2)
Drilling mc.1spd.(30mm)			■(5)	■(60)	■(144)
Drilling mc.(50mm)					■(1)
Total number of models	5	6	8	8	7
inc.new models		1	3	4	6
Total annual output	(803)	(1487)	(3459)	(2203)	(1666)

4. 'Samotochka'

Model	1928/29	1929/30	1931	1932	1933
Lathe (T-130)	x(11)	x(90)	x(80)		
Shaping (Sh-3)	x(144)	x(253)	x(676)	x(192)	
Shaping (Sh-3Modzd.)				■(535)	■(717)
Shaping (Sh-5)					■(1)
Slotting (D-1)				■(16)	■(67)
Total number of models	2	2	2	3	3
inc. new models				2	3
Total annual output	(155)	(343)	(758)	(733)	(785+)

5. im.TsK Mashinostroeniya

Models	1928/29	1929/30	1931	1932	1933
Sharpening mc.	x(88)				
Drilling mc.(40mm)	x(188)	x(215)			
Lathe(200mm h.of c.)	x(14)	x(39)			
Lathe(TV-155)	x(289)	x(730)	x(1453)	x	x
Lathe(TB-200)				■(48)	■(225)
Thread-milling mc.(563)					■(8)
Metal saw (860)					■(1)
Total number of models	4	3	1	2	4
inc. new models				1	3
Total annual output	(579)	(984)	(1485)		

6. 'Komsomolets'

Table SA.XIII cont.

Model	1928/29	1929/30	1931	1932	1933
Shaping mc.(Sh-40)	x(77)	x(159)	x(462)	x(2)	
Lathe(TV-20)	x(30)	x(103)	x(2)	x	x
Combined mc.(190)			■(1)	■(30)	■(132)
Gear-cutting mc.(532)					■(14)
Total number of models	2	2	3	3	3
inc. new models			1	1	2
Total annual output	(107)	(262)	(465)		(417)

New Factories

7. im.Ordzhonikidze

Model	1928/29	1929/30	1931	1932	1933
Turret lathe (136)				■(36)	■(465)
Semi-auto.(114)					■(1)
Total number of models				1	2
Total annual output				(37)	(466)

8. Gor'kii milling machine

Model	1928/29	1929/30	1931	1932	1933
Univl.milling(632)				■(28)	■
Horiz.milling(6G82)					■(418)
Vertx.milling(612)					
Total number of models				1	2
Total annual output				(28)	(418)

9. Khar'kov im.Molotova

Model		1929/30	1931	1932	1933
Radial-drilling mc.(256)					■(1)
Grinding mc.(3A12)					■(1)
Total number of models					2
Total annual output					(4)

x production of an old model, defined as a pre-1928 design and/or a design falling well below the prevailing technical level of machine tool building of the period.

■ production of a new model corresponding to the prevailing world technical level of machine tool building.

(...) annual output of a given model.

* in some cases total output includes a small number of miscellaneous and special machines not covered by the models listed.

Summary

Table SA.XIII cont.

	1928/29	1929/30	1931	1932	1933	1934*
a. Old Factories						
Number of Models	24	24	18	22	28	47
Inc. New Models	0	2	5	11	22	43
Propn. New Models(%)	0	8.3	27.8	50.0	78.6	91.5
<u>Output</u>						
Old Models (units)	2552	4796	8890	6147	2727	2000
New Models (units)	0	53	72	1099	3480	4410
Total Output (")	2552	4849	8962	7246	6207	6410
Propn. New Models(%)	0	1.1	0.8	15.2	56.1	68.8
b. New Factories						
Number of New Models			0	2	6	13
Output of New Models(units)			0	65	888	1190
c. All Factories of Stankoob"edinenie						
Number of Models	24	24	18	24	34	60
Inc. New Models	0	2	5	13	28	56
Propn. New Models(%)	0	8.3	27.8	54.2	82.4	93.3
<u>Output (units)</u>						
Old Models	2552	4796	8890	6147	2727	2000
New Models	0	53	72	1164	4368	5600
Total Output	2552	4849	8962	7311	7095	7600
Propn. New Models(%)	0	1.1	0.8	15.9	61.6	73.7
<u>Output per Model (units)</u>						
Old Models	106	218	684	559	455	500
New Models	0	27	14	90	156	100
<u>Annual Change:</u>						
Old Models Withdrawn		2	9	2	5	2
New Models Introduced		2	3	8	15	28

*The detailed data on models and output presented for 1928/29 - 1933 are not available for 1934. This column presents estimates based on the limited information available.

Source:

Compiled from a wide range of diverse sources, but primarily: Lebyachenko, 1932; Tsaguriya, M., Osvoenie novykh predpriyatiy, 1934; Tyazhelaya promyshlennost' SSSR za 1931-34gg; 1935; Stanki, katalog, 1932; Aizenshtadt and Chikhachev; Slavnye traditsii.

Table SA.XIV

YEAR OF FIRST SOVIET PRODUCTION OF THE MAIN TYPES OF MACHINE TOOL

Type	Year ¹	Model	Factory	Szd/Mty. ²
<u>Lathes</u>				
Centre-toolroom*	1932	1D62	'Krasnyi Proletarii'	Szd
Multi-tool	1933	173	"	Szd
Relieving	1934	181	"	Szd
Precision ('Sip')	1934	1612P	im.Voskova	Szd ⁺
Crankshaft	1936	187	'Krasnyi Proletarii'	Szd
<u>Combined mc.tool</u>	1932	190	'Komsomolets'	Szd
<u>Vertical Turning & Boring Mill</u>	1936	152	'Stankokonstruktsiya'	Szd
<u>Turret Lathe*</u>	1932	136	im.Ordzhonikidze	Szd
<u>Automatics & Semi-Automatics</u>				
Single-spindle auto	1934	1110	im.Frunze (Penza), No.50	Mty
Four-spindle auto	1936	123	im.Ordzhonikidze	Szd
Six-spindle auto	1939	126	im.Gor'kogo	Szd
Single-spindle s-a	1934	114	im.Ordzhonikidze	Szd
Four-spindle s-a	1937	123A	"	Szd
Six-spindle s-a	(1938)	127	im.Gor'kogo	Szd
Vertical Six-spdl. s-a	1937	1283	'Krasnyi Proletarii'	Szd
<u>Drilling Machines</u>				
Vertical*	1931	221	im.Lenina	Szd
Radial*	1934	256	im.Molotova	Szd
<u>Boring Machines</u>				
Horizontal*	1931	262	im.Sverdlova	Szd
Diamond-boring	1938	269	im.Lenina	Szd

Type	Year	Model	Factory	Szd/Mty.
<u>Grinding Machines</u>				
Cylindrical*	1934	3A12	im.Molotova	Szd
Centreless	1934	3181	Tula, No.8	Mty
Surface	1935	372	im.Kalinina, No.4	Mty
Internal	1935	325	Lugansk, No.60	Mty
Crankshaft-grinding	1936	342	im.Molotova	Szd
Thread-grinding	1937	586	im.K.Liebknecht, No.77	Mty
<u>Honing Machines</u>				
	1938	383	im.Lenina	Szd
<u>Gear-cutting Machines</u>				
Gear-milling	1933	532	'Komsomolets'	Szd
Gear-shaping	1934	512	'Krasnyi Proletarii'	Szd
Gear-shaving	1938	571	'Komsomolets'	Szd
<u>Milling Machines</u>				
Universal*	1931	681	Tula, No.8	Mty
Horizontal*	1932	6G82	Gor'kii ZFS	Szd
Vertical	1933	612	"	Szd
Plano-milling	1934	655	"	Szd
Copying-milling	1935	642	Tula, No.8	Mty
Thread-milling	1934	563	im.TsK Mash.	Szd
Drum-type	1939	6511	Gor'kii ZFS	Szd
Copying-milling with photo-electric control	1940	6441	im.Sverdlova	Szd
<u>Planing Machines*</u>				
	1932	713	im.Sverdlova	Szd
<u>Shaping Machines*</u>				
	1931	735	'Samotochka'	Szd
<u>Slotting Machines*</u>				
	1932	741	"	Szd
<u>Broaching Machines</u>				
Internal, horizontal	1936	751	" /im.Kirova (Minsk)	Szd
Internal, vertical	1940	772	im.Kirova (Minsk)	Szd
Surface, vertical	1938	774	'Stankokonstruktsiya'	Szd

Table SA.XIV cont.

Type	Year	Model	Factory	Szd/Mty.
<u>Disc Saws</u>	1933	860	Im.TsK Mash.	Szd
<u>Centring Machines</u>	1934	2831	'Krasnyi Proletarii'	Szd
<u>Unit-construction Machines</u>	1934	24 spd.	'Stankokonstruktsiya'	Szd

Notes

1.Year first example built.

2.Szd. - factory of the specialized machine tool industry.

Mty. - military factory.

* first modern model. Previous Soviet products of this type of pre-war (1914) design or primitive, simple models.

+ tooling factory of the specialized machine tool-tooling industry.

(...) approximate.

Source:

Compiled from a wide range of diverse sources, primarily catalogues, price lists, newspapers and journals. Main book sources Lebyachenko, Aizenshtadt and Chikhachev, and factory histories.

Table SA.XV

ORIGIN OF THE MAIN TYPES OF MACHINE TOOLS BUILT IN THE U.S.S.R.

Factory	Year Introduced	Soviet Model	Foreign Model	Country of Origin
<u>A. Lathes</u>				
1. im.TsK Mash.	1927	TV-155 centre lathe	'Chemnitz'	Germany
2. im.Sverdlova	1928	TV-25 centre lathe	'Braun'	Germany
3. Izhevsk	1928	RUZh centre lathe	'Loewe'	Germany
4. 'Kommunar'	1929	K-29 centre lathe		Soviet
5. 'K.P.'	1929/30	TN-15;TN-20 c.-l.	.	USA?
6. Izhevsk	1931	161 ('Udmurt') c.-l.	'American Tool'	USA
7. 'K.P.'	1932	1D62 ('DIP') c.-l.	'V.D.F.'	Germany
8. im.Dzerzh.	1932/33	1P613(TV-13) precision	'Boley u.Leinen'	Germany
9. 'K.P.'	1933	172;173 (MT-20&30) stub L.	'Sundstrand'	USA
10. 'K.P.'	1933	1D63 ('DIP') c.-l.	'V.D.F.'	Germany
11. im.Voskova	1934	503 (PVT-3) precision	'Sip'	Switzerland
12. im.TsK Mash.	1934	162SP c.-l.(modsd.TV155)		G./Soviet
13. 'Kommunar'	1934	1K617 c.-l.(modsd.K-29)		Soviet
14. Izhevsk	1934/35	161A & range(mod. 161)		USA/Soviet
15. 'K.P.'	1934/35	181 relieving lathe	'Reinecker'	Germany
16. 'K.P.'	1934/35	1D64 & 1D65 c.-l.	'V.D.F.'	Germany
17. 'K.P.'	1937	162K (No.26) c.-l.)	'Monarch'	USA
18. 'Kommunar'	1938	1618 & range		Soviet
19. 'K.P.'	1940	No28 c.-l.		Soviet?
<u>B. Turret Lathes</u>				
1. im.Kalinina(L)	1932	R-1;R-2 (25 & 40 mm)	'Ward'	U.K.
2. im.Ordzh.	1932	136; 137 (63 & 85mm)	'Warner & Swasey'	USA
3. im.Dzerzh.	1933/34	1A32 (25mm,precision)	'Boley u.Leinen'	Germany
4. 'Kommunar'	1935	1V32 (25mm,hand feed)	'Hasse u. Wrede'	Germany

Factory	Year Introduced	Soviet Model	Foreign Model	Country of Origin
<u>C.Semi-automatics and Automatics</u>				
1. im.Frunze	1934	1110;1118 1spdl.auto.	'Index'(Hahn u. Kolb)	Germany
2. im.Ordzh.	1934	114 semi-auto. 1spdl.	'Scheu'	Germany
3. im.Ordzh.	1935	116 semi-auto. 1spdl.	'Fay'(Jones & Lamson)	USA
4. im.Ordzh.	1936	118 semi-auto. 1spdl.	'Fay'(Jones & Lamson)	USA
5. im.Ordzh.	1936/37	123;126 4spdl. auto.	'Cone'	USA
6. 'K.P.'	1938	1283 vertl.6 spdl.s.-a.	'Bullard'	USA
7. Kiev	1939/40	1124;1136 1spdl.auto.	'Tornos'	Switzerland
8. L.turrets & autos.	1940	111;111P 1spdl.auto.		Soviet
<u>D.Drilling Machines</u>				
1.im.Sverdlova	1929	Radial drilling mc.	'Cincinnati-Bickford'	USA
2.im.Lenina	1932	221 vertical 18mm.	'Avey'	U.K.
3.Khar'kov	1933/34	256 radial	'Cincinnati-Bickford'	USA
4.im.Lenina	1932	213 vertical 30mm	'Cincinnati-Bickford'	USA
5.im.Lenina	1934	215 vertical 50mm	'Alfred Schütte'	Germany
6.im.Lenina	1935/36	2125;2135;2150;2175 v.		Soviet
7.Khar'kov	1935/36	2A56 & range radial		Soviet
8.Khar'kov	1940	A-3 multi-spdl.unit cn.	'Kingsbury'	USA
9.im.Voroshilova,Minsk	1941	2535 radial		Soviet
<u>E.Boring Machines</u>				
1.im.Sverdlova	1932	262 (R-80) 80mm horiz.	'Union'	Germany
2.im.Sverdlova	1934	261 (R-60) 60mm horiz.		Soviet
3.im.Sverdlova	1935	263 (R-110) 110mm horiz.		Soviet
4.im.Sverdlova	1939/40	262A;263A 80 & 110mm h.		Soviet
<u>F.Milling Machines</u>				
1.Tula	1931	681;681G ('Dzerzhinets')	'Cincinnati'	USA
2.Gor'kii	1932	6G82;682;612	'Cincinnati'	USA

Factory	Year Introduced	Soviet Model	Foreign Model	Country of Origin
3.Gor'kii	1934	680M;610;680	'Cincinnati'	USA
4. Gor'kii	1934/35	6G83;683	'Cincinnati'?	USA?
5. Gor'kii	1934/35	655;665 plano-miller	'Cincinnati'?	USA?
6. im.TsK.Mash.	1936	561 thread miller	'Wanderer'	Germany
7. Tula	1936	651 plano-miller		Soviet
8.im.Sverdlova	1940	6441 copy miller		Soviet
<u>G.Grinding Machines</u>				
1.im.Sverdlova	1929	Universal grinder	'Fortuna'	Germany
2.Tula	1934/35	3181 centreless grdr.	'Cincinnati'	USA
3.Lugansk, No60	1934	3V12 universal grdr.	'Churchill'	U.K.
4.Lugansk No60	1934/35	3G12 universal grdr.	'Fritz Werner'	Germany
5.Khar'kov & Zlatoust	1935	3A12 universal grdr.	'Fortuna'	Germany
6.Khar'kov	1936	342 crankshaft grdr.	'Landis'	USA
7.Khar'kov	1936	352 splined shaft grdr.	'Fritz Werner'	Germany
8.im.Il'icha	1936	3A64 tool and cutter grdr.	'Cincinnati'	USA
9.im Kalinina & Samatohka	1936/37	372 surface grdr.	'Norton'	USA
10.Khar'kov	1936/37	316 & range, universal grdr.		Soviet
11.im.Karla Liebknecht	1937/38	585 thread grinder	'Lindner'?	Germany?
12.Khar'kov	1939	3A15 & range, universal grdr.		Soviet
13.Lugansk No60 & Stankonormal	1935/39	324A;325 internal grdr.	'Heald'	USA
<u>H.Gear Cutting Machines</u>				
1.Komsomolets	1933	532 gear milling mc.	'Pfauter'	Germany
2.'K.P.' & im.Kalinina	1935	512 gear slotting mc.	'Fellows'	USA
3.'Komsomolets'	1936	534 gear milling mc.	'Barber-Colman'	USA

Factory	Year Introduced	Soviet Model	Foreign Model	Country of Origin
<u>I. Planing Machines</u>				
1.im.Sverdlova	1932	713 (3-PS)	'Böhringer'	Germany
2.im.Sverdlova	1933	712 (2-PS)	'Böhringer'	Germany
3.im.Sverdlova	1940	7A131;7A132;7A142		Soviet
<u>J. Shaping Machines</u>				
1.'Samotochka'	1933	736 (Sh-5)		Soviet
<u>K. Slotting Machines</u>				
1.'Samotochka'	1932	741 (D-1)	'Ravenburg'	Germany
2.'Samotochka'	1934	742 (D-2)	'Butler'	U.K.
<u>L. Other Machines</u>				
1.im.Lenina	1931	507 threading mc.	'Landis'	USA
2.'Komsomolets'	1932	190 combined mc.	'Krause'	Germany
3.im.TsK.Mash.	1933	860 disc saw	'Heller'	Germany
4.im.Sedina	1937	152 vertical boring mill		Soviet
5.im.Lenina	1938/39	915 pipe threading		Soviet
6.im.Sedina	1940	155;156 vert.boring mill	'Schliess-Defries'	Germany

Source: See next page.

Table SA.XV

Sources:

The following sources refer only to the identification of the foreign models concerned.

A. Lathes

1. Lebyachenko, p27.
2. 15 let bor'by za sovetskoe mashinostroyeniye, p46.
3. Izvestiya, 21-7-30.
4. Kostsov, V.P.; Vantsak, B.S., Putyami otsov, Khar'kov, 1965, p23.
5. From illustrations.
6. Izvestiya, 21-7-30.
7. ZaInd., 1-5-31.
8. SiI, 1933, No1, p7.
9. SiI, 1934, No4, p1.
10. Same range as 1D62.
11. ZaInd., 19-10-34.
12. Besspalov, V., Bol'shaya zhizn', Kuibyshev, 1949, p21.
13. Kostsov, V.P.; Vantsak, B.S., op cit, p30.
14. ZaInd., 24-9-34; Organizatsiya upravleniya, 1934, No1, p95.
15. Problemy ekonomiki, 1934, No6, p139; Machinist, 16-2-35, p40E.
16. as 10.
17. Plan. Khoz., 1937, No7, p42.
18. Kostsov & Vantsak, op cit, p33.
19. SiI, 1940, No10, p18.

B. Turret Lathes

1. Kholmianskii, I., Spetsializatsiya i kooperirovaniye mashinostroyeniya v pervoi pyatiletke, M.-L., 1933, p291.
2. ZaInd., 29-10-32.
3. SiI, 1933, No1, p7.
4. SiI, 1933, No1, p6.

C. Semi-autos and automatics

1. ZaInd., 22-7-34.
2. ZaInd., 9-5-35.
3. Machinist, 4-3-34.
4. Mashinostroyeniye, 28-11-39.
5. ZaInd., 9-5-35; Mashinostroyeniye, 28-11-39.
6. Identified from contemporary photographs.
7. Economic Survey of the USSR, 1936, May, pp36-37.
8. SiI, 1939, No10-11, pp9-10.

D. Drilling Machines

1. Aizenshtadt & Chikhachev, p175.
2. ZaInd., 1-5-31.
3. ZaInd., 24-5-34.
4. ZaInd., 1-5-31.
5. ZaInd., 6-1-34.
6. Mashinostroyeniye, 18-3-40.
7. Khar'kovskii stankostroyitel'nyi, op cit, p17.
8. ibid, pp43-44.
9. Bogushevich, Yu.K.; Grebennikov, D.G., Im. Velikogo Oktyabrya, Minsk, 1967, p75.

E. Boring Machines

1. 15 let bor'by za sovetskoye mashinostroyeniye, op cit, p50.
2. Borisov & Vasil'ev, op cit, p153.
3. ZaInd., 15-2-35.
4. Borisov & Vasil'ev, op cit, p176.

F. Milling Machines

1. Pravda, 3-4-31.
2. Front Nauka i Tekhnika, 1932, No2, p22.

Source Table SA.XV cont.:

3. Identified from contemporary photographs.
4. Identified from contemporary photographs.
5. Identified from contemporary photographs.
6. SiI, 1934, No1, p4.
7. ZaInd., 24-2-36.
8. Borisov & Vasil'ev, p177.

Grinding Machines

1. Aizenshtadt & Chikhachev, p175.
2. ZaInd., 24-2-36.
3. ZaInd., 12-4-34.
4. ibid.
5. ZaInd., 22-6-34.
6. ibid.
7. ibid.
8. ZaInd., 27-2-36
9. SiI, 1936, No8, p5.
10. Khar'kovskii stankostroitel'nyi, p17.
11. Implied by Aviapromyshlennost', 1935, No6, p29.
12. Khar'kovskii stankostroitel'nyi, p35.
13. ZaInd., 12-4-34.

H. Gear-cutting Machines

1. SiI, 1933, No1, p6.
2. SiI, 1934, No4, p1; Voprosy istorii, 1970, No10, p120.
3. Problemy ekonomiki, 1936, No4, p58.

I. Planing Machines

1. ZaInd., 1-5-31.
2. Closely related to 713.

J. Shaping Machines

1. ZaInd., 15-9-33.

K. Slotting Machines

1. ZaInd., 1-5-31
2. ZaInd., 14-9-34

L. Other Machines

1. Lebyachenko, p23
2. Pravda, 7-11-31
3. SiI, 1934, No4, p1
4. ZaInd., 17-5-36
5. SiI, 1947, No11, p11
6. 50let Krasnodarskii stankostroitel'nyi, Krasnodar, 1961, p55.

Soviet Metal-cutting Machine tool Imports , 1913 - 1940

Year	Machine tool imports in terms of:			
	Value ('000 rubles)	Weight (tonnes)	Number of Units	Value per Unit(r.)
1913	12,788	18,689		
1921	9	16		
1921/22	19	33		
1922/23	263	393		
1923/24	798	1,193		
1924/25	4,312	2,826		
1925/26	6,329	4,863		
1926/27	19,429	16,471		
1927/28	20,046	16,358		
1928(4thQ)	3,119	1,787		
1929	16,275	9,602	5,000	3,255
1930	41,466	23,165	9,000	4,607
1931	85,225	52,374	14,000	6,088
1932	82,256	60,947	12,000	6,855
1933	38,634	39,500	7,746	4,988
1934	14,184	11,455	4,398	3,225
1935	13,667	13,560	3,374	4,051
1936	40,336	35,321	8,157	4,945
1937	23,561	25,375	3,916	6,017
1938	43,770	33,830	6,078	7,201
1939	39,195	40,197	3,458	11,335
1940	33,166	22,201	4,589 (9,274)	7,227

Source: a. 1913-1927/28: *Vneshnyaya torgovlya SSSR za 1918-1940gg*, M., 1960, pp204, 237, & 269. Note: this series includes some items which are not strictly metal-cutting machine tools.

b. 1928(4thQ)-1932: *Voznesenskii, A.N.; Voloshinskii, A.A. (eds.), Vneshnyaya torgovlya SSSR za pervuyu pyatiletku*, M., 1933, pp308-309. Note: metal-cutting machines only, therefore not directly comparable with previous years. Data on these years given in source a. are inflated by the inclusion of non-metal-cutting machine tool item. Units: *ZaInd.*, 23.6.33.

c. 1933-1940: as a., pp334, 368, & 402. Note: categories were revised in 1934; data for 1934-1940 believed to be comparable with 1928(4thQ)-1932.

d. 1940(9,274): alternative given by Kas'yanenko, V.I., *Zavoeevanie ekonomicheskoi nezavisimosti SSSR*, M., 1972, p299.

Value per unit calculated from number of units and value.

Machine tool Imports as a Proportion of all Machinery and Equipment
Imports and Total Imports(per cent)

Year	Machine tool imports as a proportion of:		Machinery and Eq'ment Imports as a propn. of Total Imports
	Machinery and Eq'ment Imports	Total Imports	
1913	5.59	0.93	16.6
1922/23	0.83	0.18	21.0
1923/24	2.57	0.34	13.3
1924/25	4.37	0.60	13.7
1925/26	4.07	0.84	20.6
1926/27	12.37	2.72	22.0
1927/28	8.87	2.12	23.9
1928(4thQ)	6.32	1.53	24.2
1929	6.14	1.85	30.1
1930	8.37	3.92	46.8
1931	14.31	7.71	53.9
1932	21.00	11.68	55.7
1933	25.80	11.09	43.0
1934	24.36	6.10	25.0
1935	24.05	5.66	23.5
1936	33.52	13.06	39.0
1937	29.49	8.08	27.4
1938	40.52	13.99	34.5
1939	47.38	18.35	38.7
1940	32.35	10.48	32.4

Source: Machine tool imports - from Table
 Machinery and equipment imports, and total imports - Vneshnyaya
Torgovlya SSSR za 1918-1940, pp 204,237,269,301,334,368 & 402.
 Percentages calculated.

Table SA.XVIII

The Level of Import Dependence , 1929 - 1940

Year	Mc.t.Imports (units)	Domestic Prodn. (units)	Imports as Propn. of total supply(%)
1929	5,000	(5,000)	(50.0)
1930	9,000	(9,250)	(49.3)
1931	14,000	18,317	43.3
1932	12,000	19,720	37.8
FYP(1)	40,000	52,287	43.3
1933	7,746	20,998	26.9
1934	4,398	25,400	14.8
1935	3,374	33,900	9.1
1936	8,157	44,400	15.6
1937	3,916	48,473	7.5
FYP(2)	27,591	173,171	13.7
1938	6,078	55,500	9.9
1939	3,458	55,035	5.9
1940	4,589	58,473	7.3
1938-40	14,125	169,008	7.7

Source:

Imports - from Table SA.XVI.

Domestic Production - from Table SA.I.

Note - 1929 and 1930 Output estimated from known economic year totals.

Import Dependence by Type of Machine Tool , 1936-37¹Table SA.XIX

Type of Machine	Imports 1936 (units)	Domestic Prod'n. 1937 (units)	Ratio:Imports to Domestic Prdn.
Shaping mc.	24	3172	0.008
Vertical drilling mc.	679	12235	0.055
Lathes	1767	15202	0.116
Tool & cutter grg.mc.	288	2045	0.141
Slotting mc.	50	250	0.200
Turret lathes	382	1806	0.212
Milling mc.	699	3243	0.216
Planing mc.	80	303	0.264
Horiz.boring mc.	57	131	0.435
Autos.& semiautos.	407	894	0.455
Breaching mc.	28	44	0.636
Grinding mc.	1307	1839	0.711
Radial drilling mc.	462	585	0.790
Gear-cutting mc.	599	397	1.509

Source: Imports 1936 - Statistika vneshnei torgovlya, 1936, No.12, pp99-101.

Prod'n. 1937 - Table SA.VII.

1. Fully comparable data only available for imports in 1936 and Soviet domestic output in 1937. Actual dependence for all types must have been higher than indicated in 1936, but lower in 1937.

Table SA.XX

The Structure of Machine Tool Imports by Country of Origin
(as a percentage of total imports)

Year	Germany		U.S.A.		Britain		Other	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
1913	80.3	83.3	3.3	3.0	11.5	9.4	4.9	4.3
1924/25	31.2	27.1	16.1	18.4	36.1	36.0	16.6	18.5
1925/26	55.7	52.8	9.9	12.0	17.7	17.2	16.7	18.0
1926/27	69.8	64.3	2.9	5.0	1.9	2.5	25.4	28.2
1927/28	70.1	62.9	4.1	6.8	0.9	0.6	24.9	29.7
1935	25.5	30.3	25.9	23.1	34.0	25.6	14.6	21.0
1936	58.4	56.2	28.1	33.0	5.1	3.7	8.4	7.1
1937	74.6	71.5	10.2	16.2	3.5	4.7	11.7	7.6
1938	9.2	7.9	57.7	62.9	26.7	22.9	6.4	6.3
1939	17.7	16.3	45.4	50.5	27.4	23.5	9.5	9.7
1940	42.5	38.0	42.7	46.9	0.6	0.3	14.2	14.8

Source: Calculated from, Vneshnyaya trgovlya SSSR za 1918-1940gg, M., 1960.

Note: Proportion of U.S.A. imports for 1913-1927/28 estimated by taking 80 per cent of the given total for all metal-working equipment; for 1935-1940, as a residual.

The American and British proportions for 1926/27-1927/28 are believed to be understated; the 'other' category probably includes imports from these countries.

Equivalent information for 1929-1934 not available.

The Structure of all Machinery and Equipment Imports, 1929-1934

(as a percentage of total imports by value)

Year	Germany	U.S.A.	Britain	Other
1929	49.7	35.6	8.9	5.8
1930	39.5	49.6	6.9	4.0
1931	47.1	43.1	7.6	2.2
1932	70.0	8.7	19.0	2.3
1933	78.2	5.9	11.9	4.0
1934	43.5	27.1	20.3	9.1

Source: as above.

The Structure of Machine Tool Imports by Type of Machine, 1929 - 1938
(in value terms)

Type of Machine	Structure of imports - per cent of total by value				
	1929	1930	1931	1932	1933
Lathes.....	23.3	23.9	21.5	28.4	10.6
Turret Lathes.....	10.8	10.5	11.6	7.9	3.2
Autos.& Semiautos.....	0.8	4.7	5.0	6.9	15.6
Drilling & Boring mcs.	17.0	16.8	18.0	18.3	16.3
Milling machines.....	25.1	21.0	16.9	15.7	31.1
Grinding machines.....	14.9	13.5	14.7	13.3	} 16.3
Tool & Cutter grdg.mcs	4.0	2.7	3.0	2.0	
Planing & Shaping mcs.	5.1	6.9	9.3	7.5	6.9
Total	100.0	100.0	100.0	100.0	100.0
Total					
	1934	1935	1936	1937	1938 ¹
Lathes	32.8	35.6	33.7 ²	45.1 ³	11.7
Turret Lathes.....	7.6	3.2	5.5	} 8.1	17.6
Autos & Semiautos.....	9.8	8.7	9.4		
Drilling & Boring mcs	13.6	17.4	12.6	13.1	17.9
Milling machines.....	9.7	9.6	8.8	11.8	15.1
Grinding machines.....	} 23.9	20.5	22.2	15.6	29.8
Tool & Cutter grdg.mcs			1.7	1.0	1.0
Planing & Shaping mcs.	2.6	5.0	6.1	5.3	6.9
Total.....	100.0	100.0	100.0	100.0	100.0

1. January to September only.

2. Including special lathes - 17.7 per cent.

3. Including special lathes - 31.8 per cent.

Source:

1929 - 1932: Calculated from . Voznesenskii, A.N. & Voloshinskii, A.A., Vneshnyaya trgovlya SSSR za pervuyu pyatiletku, M., 1933, pp.308-309.

1933 - 1935: Calculated from , Mishustin, D.D., Vneshnyaya trgovlya i industrializatsiya SSSR, M., 1938, p.148.

1936: Calculated from , Statistika vneshnei trgovli SSSR, 1936, No.12, pp.99-101.

1937: ibid., 1937, No.12, p.40.

1938: ibid., 1938, No.12, p.40.

Table SA.XXII

The Structure of Imported Lathes , 1929 - 1932, and 1936
(Proportion of total lathe imports by value)

Type of Lathe	1929	1930	1931	1932	1936
Standard single-tool	9.7	46.5	39.9	37.2	8.0
Standard multi-tool	6.7	0.9	3.5	0.4	0.7
Turret	30.1	26.9	30.5	18.3	11.2
Auto.& Semiautomatic	2.2	12.0	13.2	15.9	17.3
Wheel and roll turning	-	-	0.7	5.9	16.9
Crankshaft	0.1	1.3	0.8	0.8	3.7
Vertical turning & boring	5.6	6.5	7.4	8.5	6.8
Other types	45.6	5.9	4.0	12.8	35.4
Total	100.0	100.0	100.0	100.0	100.0

Source:

1929 - 1932: Calculated from Voznesenskii, N.A., & Voloshinskii, A.A., op cit, pp.308-309.

1936: Calculated from Statistika vneshnei trgovlya, 1936, No.12, pp.99-100.

The Structure of Imported and Soviet-built Machine tools installed in the Machine building and Metal Working Industries , 1928 - 1933.

Type of Machine Tool	Structure of types of machine tool installed, as a proportion of total installations in:									
	The Machine Building Industry (%)						The Mc.Bdg. & M.Wkg. Industries (%)			
	1928		1929 & 1930		1931 & '32(Q1)		1932(Q2-Q4)		1933	
	Soviet	Imprtd.	Soviet	Imprtd.	Soviet	Imprtd.	Soviet	Imprtd.	Soviet	Imprtd.
Lathes.....	30.4	36.1	41.5	31.2	50.2	23.4	43.3	30.9	42.4	21.0
Turret Lathes,Autos and Semi-autos....	6.1	12.9	2.4	16.6	1.1	16.8	4.0	12.6	6.9	17.5
Drilling machines..	30.2	20.9	30.7	20.9	29.2	22.7	24.4	12.9	20.3	14.0
Milling machines...	2.7	11.7	2.4	12.3	3.1	14.8	4.3	15.6	7.6	15.0
Grinding machines..	16.1	8.9	9.8	12.5	5.5	15.0	8.8	29.9	10.1	26.3
Planing,Shaping and Slotting machines..	9.4	5.8	9.8	4.2	8.4	5.6	7.2	5.4	6.8	4.3
Threading machines.	5.1	3.7	3.4	2.3	2.5	1.7	4.0	1.7	5.9	1.9
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: 1928 - 1931(Q1)

Calculated from , Oborudovanie metalloobratyvayushchei promyshlennosti,M.,1935,vyp.1,pp60-62. (data refer to 75 per cent of total installations in the civilian machine building industry)

1932(Q2-Q4) - 1933

Calculated from, ibid,vyp.1,pp58-59.(all installations in civilian machine building and metal working)

Indicators of the Technical Level of Imported and Soviet-built Machine tools installed in the Machine-Building Industry , 1928 - 1932

Year of Installation and Type of Machine	Average Power(h.p.)		Type of Feed and Speed change Mechanism* (per cent of total)							
			Without Power Feed	Imprtd.	With Power Feed					
					With Stepped-pulley Drive				With Drive through a Gearbox	
	Soviet	Imported			Without Feed- change mechs.		With Feed- change mechs.		Soviet Imprtd.	
<u>Lathes</u> 1928	1.8	4.5	8.2	27.3	69.2	31.2	17.4	14.9	5.2	26.6
1929 & 1930	2.3	4.3	3.3	20.0	59.8	29.2	29.3	11.8	7.6	39.0
1931 & 1932(1Q)	2.6	5.5	4.1	10.8	46.2	22.5	38.1	11.8	11.6	54.9
<u>Turret lathes</u> ⁺ 1928	2.3	3.8	97.1	58.8	2.9 28.4				-	18.8
1929 & 1930	2.7	3.5	75.4	31.4	19.3 23.1				5.3	45.5
1931 & 1932(1Q)	2.7	5.6	75.5	18.4	18.4 12.9				6.1	68.7
<u>Drilling mcs.</u> 1928	2.1	3.3	88.8	53.6	1.8	2.2	6.5	14.0	2.9	30.2
1929 & 1930	2.3	3.2	78.8	54.1	3.5	2.0	14.3	17.5	3.4	26.4
1931 & 1932(1Q)	2.1	4.0	77.1	38.0	1.6	2.8	16.0	16.4	5.3	42.8
<u>Milling mcs.</u> 1928	2.5	4.5	25.0	5.1	25.0	31.6	31.3	23.3	18.7	40.0
1929 & 1930	2.5	4.2	27.3	16.2	24.7	17.1	38.9	16.7	9.1	50.0
1931 & 1932(1Q)	2.1	5.2	50.0	6.7	17.9	13.2	19.9	15.1	12.2	65.0
<u>Planing mcs.</u> ^{**} 1928	4.0	7.3	3.8	8.9	67.3 49.0				28.9	42.1
1929 & 1930	3.5	6.2	3.6	5.1	49.5 40.1				46.9	54.8
1931 & 1932(1Q)	3.3	8.4	3.5	3.0	38.0 25.6				58.5	71.4

*Excluding automatic and semi-automatic machines.

⁺Including automatics and semi-autos.

^{**}Including shaping and slotting machines.

Source: Oborudovanie metalloobratyvyayushchei promyshlennosti, M., 1935, vyp.1, pp60-62; 67-69.

Soviet Machine Tool Exports, 1934 - 1940

Table SA.XXV

Year	Total Exports		Destination of Exports (% total value)				
	Units	Value '000 r. ¹	Mongolia	Turkey	China	Holland	Other
1934	393	134	.	.	.	.	.
1935	640	34	20.3	18.6	2.7	2.5	55.9
1936	1,087	105	11.2	32.0	13.1	28.4	15.3
1937	4,931	290	5.8	9.2	8.0	36.3	40.7
1938	1,788	177	15.2	1.1	11.8	2.6	69.3
1939	792	29	62.0	2.0	1.0	22.0	13.0
1940	766	83	54.7	3.4	40.5	1.2	0.2

1. In prices of corresponding year

. no data

Source: Vneshnyaya trgovlya SSSR za 1918-1940gg., pp.155,189;571-576;889-893;
912-919;946-952;985-989.

Imported Machine Tools, Installations in the Engineering Industry during
the First Five-year Plan, and the Degree of Specialisation and Automation
of Installed Machines

Branch of Engineering	Proportion(%) of stock on 10/4/32:						Growth of stock 1/29 to 10/4/32	
	Imptd.	Spcl. ¹ & Splzd.	s-aut ² & Auto.	grdg. ³ & Turret mllg.	plang. ⁴ & Lathes	Instd. in flow ⁵	No. Instd.	Per cent Growth
<u>A.Branches with a High⁶ Proportion of Imported Machines and a High Rate of Growth during FYP(1).</u>								
Automobile building	92.8	49.9	16.5	36.5	22.5	79.8	4176	584.9
Tractor building	90.0	52.7	18.9	39.8	25.1	72.6	3409	880.9
Optical-measuring eq. for personal use.*	86.1	66.7	24.5	43.1	30.3	17.1	1658	325.7
Electric power eq.	84.5	35.2	7.2	31.1	36.3	19.1	2143	77.7
Control-measuring eq.	77.4	51.0	5.3	33.7	41.7	3.6	1163	93.8
Office machine bldg.	74.8	48.2	4.3	50.0	22.6	0.0	334	230.3
<u>Machine tool bldg.</u>	68.6	34.0	7.3	34.2	41.2	15.8	3103	416.0
Auto-tractor spares	67.8	39.8	11.2	32.9	44.6	10.2	1247	265.3
Weighted Average (or total).	82.0	45.2	13.0	35.8	33.2	35.7	(17233)	244.5
<u>B.Branches with a Low Proportion of Imported Machines and a High Rate of Growth during FYP(1).</u>								
Food industry eq.	58.7	20.3	2.4	17.0	55.2	3.6	1010	94.8
Misc.transport eq. ⁺	58.5	32.0	7.7	26.1	36.4	16.2	721	136.0
Agricultural mc.bdg.	55.1	24.0	3.0	18.8	38.1	26.2	3767	123.7
Lifting and industrl. transport eq. bdg.	54.6	19.0	2.1	12.3	55.9	11.2	831	76.7
Road-constrn.eq.bdg.	54.1	18.7	1.9	11.1	58.7	3.0	790	78.8
Forestry eq.bdg.	53.3	12.9	0.6	16.2	62.0	1.1	196	74.8
Weighted Average (or total)	55.7	22.5	3.0	17.3	46.2	16.4	(7315)	104.7

* including clocks, watches and photographic equipment.

+ including bicycles.

Branch of Engineering	Proportion (%) of stock on 10/4/32:						Growth of stock 1/29 to 10/4/32	
	Imptd.	Splzd. & spl.	Auto. & s-auto	Turret Mllg. & grdg.	Lathes & plng.	Instd. in flow	No. Instd.	Per cent Growth
<u>C.Branches with a High Proportion of Imported Machines and a Low Rate of Growth during FYP(1).</u>								
Communications eq.	83.7	44.7	7.5	30.5	33.5	4.5	1322	47.5
Metallurgical eq.	80.3	21.0	4.7	12.4	67.0	3.9	389	55.0
Printing & paper eq.	75.0	19.5	4.7	15.0	55.2	22.9	84	49.4
Textile machinery	73.2	36.9	4.6	29.7	52.4	3.5	671	33.4
Boiler making	70.1	16.1	1.0	10.8	57.5	6.4	200	62.9
Fuel & ore eq.	68.1	21.8	3.8	17.6	56.5	5.9	996	66.6
Weighted Average (or total)	76.5	34.3	5.3	24.4	48.1	4.7	(3662)	48.9
<u>D.Branches with a Low Proportion of Imported Machines and a Low Rate of Growth during FYP(1).</u>								
Pumps & compressors	62.6	22.9	3.1	24.0	53.7	4.5	326	44.4
Misc.heavy ind. eq.	44.8	12.9	1.8	14.5	60.6	3.6	534	61.0
Misc.light ind. eq.	44.4	14.8	4.5	11.0	64.9	4.3	145	51.6
Misc.cultrl.wlfr. eq.	35.7	30.1	1.0	16.0	51.2	12.5	151	62.4
Weighted Average(or total)	49.4	18.4	2.5	17.3	57.8	5.0	(1156)	54.3
<u>E.Branches with a High Proportion of Imported Machines, a Very Low Rate of Growth during FYP(1) and a High Proportion of pre-1917 Installations,</u>								
Locomotive & wagon eq.	80.6	30.4	3.7	20.1	52.3	7.1	1248	19.2
Prime-movers bdg.	78.8	24.5	2.5	22.5	53.9	5.3	1249	27.5
Ship building	77.4	20.6	2.0	18.5	51.5	3.3	819	25.5
Misc.railway eq.	73.1	38.1	3.7	23.5	53.3	6.2	281	27.9
Weighted Average (or total)	78.9	27.0	3.0	21.5	52.7	5.7	(3597)	23.5
<u>Summary</u>								
A.High M./High Growth	82.0	45.2	13.0	35.8	33.2	35.7	52.3 ^B	244.5
B.Low M./High Growth	55.7	22.5	3.0	17.3	46.2	16.4	22.2	104.7
C.High M./Low Growth	76.5	34.3	5.3	24.4	48.1	4.7	11.1	48.9
D.Low M./Low Growth	49.4	18.4	2.5	17.3	57.8	5.0	3.5	54.3
E.High M./V.Low Grth.	78.9	27.0	3.0	21.5	52.7	5.7	10.9	23.5
Av.for all branches	74.0	33.3	6.8	26.0	44.4	18.1		84.7

Table SA.XXVI notes and source

Note : Two branches of engineering have been excluded because of the specific nature of their equipment - the making of medical instruments and the building of sewing machines.

Source: Compiled from material of the 1932 Census : Oborudovanie metalloobraty-vayushchei promyshlennosti, M., 1935, vyp. 2, Table 28 (pp112-117) and Table 30 (pp130-133)

- Notes:
1. Of 3rd, 4th and 5th degree of specialisation, according to the definition employed for the Census (see p 474).
 2. Automatic and semi-automatic machines of all types.
 3. Turret lathes (including automatics and semi-automatics), milling machines of all types, and grinding machines, including tool and cutter grinders; i.e. the basic types of progressive production equipment.
 4. Lathes; planing, slotting and shaping machines; i.e. types predominantly of a general-purpose nature.
 5. Machine tools arranged on a flow-line basis, according to the sequence of processes performed (see p.520).
 6. For the purposes of this table a 'high' proportion of imported machines in the stock of 10/4/32 is defined as 65 per cent or more; and a 'low' proportion as less than 65 per cent.
 7. Branches with a 'high' rate of growth during FYP(1) are defined as those for which the stock increased by 70 per cent or more; with a 'low' rate of growth - less than 70 per cent. In the case of Category E., over 50 per cent of the stock on 10/4/32 was installed before 1917.
 8. Percentage of total installations during FYP(1).

Table SA.XXVII

The Project Capacity of Machine Tool Enterprises
(Full project capacity as seen in various years)
(number of units)

Enterprise	1929	1930	1931	1932
'Krasnyi Proletarii'	2,325 ¹	3,600 ⁴	6,000 ⁶	6,000 ¹⁰
im.Ordzhonikidze	1,200 ²	2,400 ⁵	2,440 ⁷ /6,800 ⁸	6,140 ¹¹
Gor'kii ZFS	1,300 ²	3,400 ⁵	3,435 ⁷ /8,000 ⁹	12,500 ¹² /9,300 ¹³
Khar'kov drilling mcs.f.	1,800 ²	1,950 ⁵		1,960 ¹⁴ /1,700 ¹⁵
" grinding mcs.f.				1,500 ¹⁵
im.Sverdlova	2,000 ³	2,700 ⁴		1,300 ¹⁰
im.Lenina		4,700 ⁴		7,000 ¹⁰
'Samotochka'		2,170 ⁴		3,450 ¹⁰
'Komsomolets'				1,200 ¹⁰
im.TsK Mashinostroeniya		750 ⁴		1,650 ¹⁰
Kiev im.Gor'kogo				
Saratov g-c mc.f.				
'Stankokonstruktsiya'				275 ¹⁶
Sverdlovsk unit-c.mc.f.				
" heavy mc.t.f.				

Continued next page..

Source:

1. Torg.-prom.gaz., 1.5.29.
2. Ek.zhizn', 22.12.29.
3. ibid., 27.7.29.
4. For 1932 - SI, 1930, No.3-4, p.3.
5. Izvestiya, 19.5.1930. Note - this was the capacity at time of projection, see Vestnik metallopromyshlennosti, 1931, No.8, pp.65-66.
6. Pravda, 17.12.31.
7. ibid., 2.1.31.
8. Ek.zhizn', 29.12.31.
9. ZaInd., 29.12.31.
10. Lebyachenko, op cit, p.50.
11. Pravda, 24.12.32.
12. Ordzhonikidze, G.K., Statii i rech, Vol.2, p.330. (Jan.1932)
13. Bol'shevik, 1932, No.5, p.50.
14. 15 let bor'by za sovetskoe mashinostroenie, op cit, p.40. (early 1932)
15. Khar'kovskii stankostroitel'nyi, op cit, p.9. (second half 1932)
16. ZaInd., 24.1.32.

Table SA.XXVII cont.

The Project Capacity of Machine Tool Enterprises - continued.

1933	1934	1935	1936	1939	Ent.
6,000 ¹	2,700 ⁴	3,500 ⁹	2,700 ¹¹		'KP'
6,600 ²	3,700 ⁴	3,400 ⁹	2,400 ¹¹	2,400 ¹²	im.O.
6,700 ²	5,100 ⁴	5,000 ⁹	3,400 ¹¹	3,850 ¹²	GZFS
1,700 ³	1,750 ⁵	1,750 ⁹	} 1,220 ¹¹	1,800 ¹²	Kh.d. Kh.g.
	3,000 ⁵	2,400 ¹⁰			
	700 ⁶	800/700 ¹⁰	600 ¹¹		im.Sv.
	4,000 ⁶	3,000 ⁹	2,520 ¹¹	3,300 ¹²	im.L.
	3,000 ⁷	1,700 ¹⁰	3,000 ¹¹	900 ¹²	'S'
	1,200 ⁶	1,200 ⁹	1,250 ¹¹	1,160 ¹²	'K'.
	1,200 ⁶	900 ¹⁰	1,200 ¹¹	2,100 ¹²	im.TsK
	2,000 ⁵	2,000/650 ¹⁰	500 ¹¹	600 ¹²	Kiev
	1,500 ⁸	1,500 ⁹	750 ¹¹	*800 ¹³	S.g-c
	200 ⁴	250 ¹⁰	275 ¹¹		'StSt'
	2,300 ⁵	1,800 ¹⁰	1,800 ¹¹	** 600 ¹⁴	Sv.u-c Sv.h.
	300/150 ⁵				

*1940

**1941

Source:

1. Industrial'noe razvitie tsentral'nogo promyshlennogo raiona, 1926-32, op cit, p.461 (Feb.1933).
2. Planovoe khozyaistvo, 1933, No.1-2, p.38.
3. Izvestiya, 14.1.33.
4. ZaInd., 26.1.34.
5. Proekt vtorogo pyatiletnogo plana..., op cit, prilozhenie, pp48-49.
6. SiI, 1934, No.3, p.1.
7. ZaInd., 16.1.34.
8. ibid., 27.8.34.
9. Narodno-khozyaistvennyi plan na 1935g., op cit, p.810.
10. Problemy ekonomiki, 1935, No.4, p.193.
11. Narodno-khozyaistvennyi plan na 1936g., op cit, pp.296, 328, 350, 370, 376, 426 & 490.
12. Gosudarstvennyi plan razvitiya narodnogo khozyaistva Soyuza SSR v 1939g., op cit, pp.262-263.
13. Mashinostroenie, 8.3.40.
14. ibid., 16.8.41 (Output in 1942)

The Construction of New Machine Tool Factories - Plans and Achievement
1929 - 1941

Factory	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Im.Ordzhonikidze	FP1	PC	C	O	-	-	-	-	-	-	-	-	-
Gor'kii mllng.mc.f.	p	PC	C	O	-	-	-	-	-	-	-	-	-
Khar'kov drillg.mc.f.	FP1	PC	x	C	C	O	-	-	-	-	-	-	-
Khar'kov grndg.mc.f.				P	P	FP2P							
'Stankokonstruktsiya'		P	P	PC	C	O	-	-	-	-	-	-	-
Chelyabinsk hvy.m.f.		P	P	C	C	C	O	-	-	-	-	-	-
Gor'kii gear-ctg.m.f.		P	P	P	P	FP2P							
Sverdlovsk hvy. m.f.				P	P	FP2	x	x	x	C	C	C	C
Sverdlovsk unit-c.f.						PC	O	-	-	-	-	-	-
Kiev automatics f.						FP2	PC	O	-	-	-	-	-
Saratov gear-c.m.f.						FP2	PC	O*	-*	-*	-*	-*	-*
Voronezh grdg.m.f.						FP2P					FP3	PC	PC?
Kramatorsk hvy.m.f.										C	C	O	-
Alapaevsk autos.f.											FP3	PC	PC
Novosibirsk boring mc.f.											FP3	PC	PC?
Penza precision mf.											FP3?	PC	PC?
Planing mc.f.,Siberia											FP3		P
Gor'kii vertl.tg.&bg.				P							FP3		
Sarapul grdg.m.f.											FP3		
Univrsl.m, Far East											FP3		
Kazan broaching mf.												P	P
Vladimir unit-c.m.f.												P	P
Ryazan lathes f.													P
Ulyanovsk large lathe f.												PC	PC?

Key

p - construction proposed but not in annual or five-year plans.

FP1,2,3, - in Five-year Plan (1st,2nd,3rd).

P - construction project in annual plan.

C - under construction. Note: in all cases construction continued after factories started production.

O - start of production.

x - work suspended

- - regular production.

* - experimental shop only.

Table SA.XXVIII

Main sources:

Five-year Plans - 1st, 2nd and 3rd.

Annual plans - 1935, 36, 37, 39.

SII, 1934, No. 4, p. 40 (1934)

Mashinostroenie, 8.3.1940 (1939, 40)

Industrializatsiya SSSR, 1938-41, p. 67 (1940)

Planovoe khozyaistvo, 1941, No. 3, p. 44 (1941)

SII, 1932, No. 7, p. 2 (1932)

Khar'kovskii stankostroitel'nyi, op cit, pp. 6-33.

Sogrin, G.V., Perelisty vaya stranitsy, Chelyabinsk, 1968, pp. 228-229. (Chelyabinsk).

'176' Lathe (in.Ord.)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'177' Semi-auto (in.Ord.)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'178' Semi-auto (in.Ord.)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'2135' vert. drill (in.Ord.)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'2136' Horizontal milling (JWB)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'2137' Horizontal milling (JWB)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'2138' (B-50) Spring (in.Over-lev)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'518' gear cutting mt. (Khar'kov)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'2139' Cylindrical grinding mt. (Khar'kov)	C	1935	1936	1937	1938	1939	1940	1941
	P							
'713' (B-50) Planing mt. (in.Over-lev)	C	1935	1936	1937	1938	1939	1940	1941
	P							

A year introduced: in the 1st of the 1st year.

* not produced

+ 1st, Feb. ** 1st, Jan.

1. Cost - Annual average factory cost of production.

2. Price - Average wholesale price.

Sources are given on page 228.

Prices and Costs of Some Basic Models , 1932 - 1940 Table SA.XXIX
(rubles)

Model		1932	1933	1934	1935	1936	1937	1940
TN-20 Lathe ('KP')	C ¹ P ²		4582	4517		6670	6670	.
DIP-200 Lathe ('KP')	C P	15035 ^x	9071	7206	9830	9930	7700	7700
DIP-300 Lathe ('KP')	C P			15000 ^x 20000	18150	13040 17680	15000	15000
MT-30 Multi-tool lathe ('KP')	C P		^x 20000	12952 20000	18000	10000	10000	10000
'136' Turret lathe (im.Ord.)	C P	27202 ^x	17189	15474	13986	13574*	12500	15500
'114' Semi-auto (im.Ord.)	C P		131748 ^x	25021 25000	20000	20000	20000	.
'123' 4-spd. bar auto (im.Ord.)	C P				60000 ^x	40000	40000	40000
'2135' vert. drill (im. Lenina)	C P				24620 ^x 13000	15530** 13130	11000	11000
'682' Universal milling (GZFS)	C P	40207 ^x	17206	13500 21000	16460	15150	12500	12500
'681G' Horizontal milling (Tula)	C P	15500	11000	8860	8500 12000	9600	9600	9000
'262' (R-80) Boring (im. Sverdlova)	C P	73000 ^o		28000	31000	30300	25000	25000
'532' gear-cutting mc. (Komsomolets)	C P		^x 10000	12240 19000	15500	15660	15660	.
'3A12' Cylindrical grinding mc. (Khar'kov)	C P		^x 10000		20000	18000	16000	.
'713' (3-PS) Planing mc. (im. Sverdlova)	C P		69205 ^x	56063	43200	44440	41000	.

x year introduced; before 1932 if not indicated.

. not produced

* Jan.-Feb.

** March

^o 1931

1. Cost - Annual average factory cost of production (fabrichno-zavodskaya sebestoimost')

2. Price - Industry wholesale price (otpusknaya tsena)

Source: see next page

Sources - Table SA.XXIX

Costs

TN-20: Vestnik metallopromyshlennosti, 1935, No. 9, p. 126.

DIP-200: 1932 - ZaInd., 6.4.33; 1933-34 - as TN-20.

DIP-300: 1934 - ZaInd., 29.3.35; 1936 - ibid., 5.2.37.

MT-30: ZaInd., 29.3.35.

136: 1932 - ZaInd., 6.4.33; 1933-34 - Vestnik metallopromyshlennosti, 1935, No. 9, p. 116
1935-36 - Plan, 1936, No. 9, p. 8.

114: Vestnik metallopromyshlennosti, 1935, No. 9, p. 116.

682: 1932-33 - Plan. Khoz., 1934, No. 5-6, p. 38; 1934 - ZaInd., 29.3.35.

2135: ZaInd., 21.5.36.

681G: 1932 & 35 - ZaInd., 29.2.36; 1933-34 - ibid., 24.2.36.

262: Borisov & Vasil'ev, op cit, p. 157.

532: ZaInd., 29.3.35.

713: Vestnik metallopromyshlennosti, 1935, No. 9, p. 116.

Prices

1932 - ZaInd., 23.7.31.

1933 - ibid., 3.8.32.

1934 - ibid., 29.3.35.

1935 - Metallorezhushchie stanki proizvodstva zavodov SSSR, M.-L., 1935;
Nashe stroitel'stvo, 1935, No. 8, p. 36.

1936 - Preiskurant otpusknykh tsen na metallorezhushchie stanki proizvodstva zavodov SSSR 1936g., M., 1936.

1937 - Preiskurant otpusknykh tsen na metallorezhushchie stanki proizvodstva zavodov SSSR 1937g., M., 1937.

1940 - Metallorezhushchie stanki - preiskurant, 1940-41gg., M.-L., 1941.

Table SA.XXIX (continued)

Indicator	1932	1933	1934	1935	1936	1937
a. Gross Output (*000r, 1936/27 p.)	2600	9855	20825	29920		13000
b. No. of workers ¹	106	1473	2131	2790		1000
c. Output/worker (x.)	2059	5144	9770	10725		13000
d. Output - units	36	466	608	1200		10000
e. Units/worker	0.04	0.32	0.28	0.43		0.30
f. No. of types/alien	1	2	3	4		5

The Performance of Three Leading Enterprises

Table SA.XXX

1. 'Krasnyi Proletarii'

Indicator	1929/0	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
a. Gross output ('000r, 1926/7 p.)	4700	11556	19926		29256			49815			73328
b. No. of workers ¹	967	1538	2395		2770			3481			3125
c. Output/worker(r)	4860	7513	8320	7987	10566	11565	12563	14310	17139	20384	23462
d. Output - units	1249	2190	2378	2200	2640	(2700)	2756	2900	3625	(4000)	(4400)
e. Units/worker	1.29	1.42	0.99		0.95			0.83			1.40
f. No. of types/sizes built*	6	5	6	12	15	17	20	23	24	25	28
g. Av. no. units per type/size	208	438	396	183	176	159	138	126	151	160	157

2. Gor'kii Milling Machine Factory

Indicator	1932	1933	1934	1935	1936	1937
a. Gross Output ('000r, 1926/27 p.)	1598	6646	19990			32000
b. No. of workers ¹	776	1292	1695		1800	(2000)
c. Output/worker(r.)	3148	6697	8670			16000
d. Output - units	28	418	548	1181	(1500)	1887
e. Units/worker	0.04	0.32	0.32		0.83	0.94
f. No. of types/sizes built*	1	2	8	11	13	15
g. Av. no. units per type/size	28	209	69	107	115	126

3. imeni Ordzhonikidze, Moscow

Indicator	1932	1933	1934	1935	1936	1937
a. Gross Output ('000r, 1926/27 p.)	2600	9865	20621	29900		53900
b. No. of workers ¹	826	1473	2131	2340		2850
c. Output/worker (r.)	2059	5144	9678	12775		18912
d. Output - units	36	466	608	1301		(2200)
e. Units/worker	0.04	0.32	0.29	0.56		0.77
f. No. of types/sizes built*	1	2	7	8	10	12
g. Av. no. units per type/size	36	233	87	163		183

(..) estimate

* approximate

1. Workers (rabochie) only

Table SA.XXXSource:1. Krasnyi Proletarii'

- a. 1929-30 - Metall, 1931, No. 1, p. 88.
- 1931 - Lebyachenko, op cit, p. 8.
- 1932 - Industrial'noe razvitie tsentral'nogo promyshlennogo raiona, 1926-32, M., 1969, p. 458.
- 1934 - Tyazhelaya promyshlennost' SSSR za 1931-34gg., M., 1935, p. 173.
- 1937 - Output inc. 1932-37 by 250 per cent - Slavyne traditsii, M., 1957, p. 187.
- 1940 - Output inc. 1932-40 by 368 per cent - Omarovskii, op cit, p. 153.
- b. 1929-30 & 32 - Prob. Ek., 1934, No. 6, p. 132.
- 1931, 34, 37, 40 - Calculated from a. and c. Note: 1940 - 3104 - Plan. Khoz, 1940, No 6, p. 33
- c. 1929-30 - calculated from a. and b.
- 1931 - 40 - Calculated using index - Omarovskii, op cit, p. 170, on basis of 1932 output/worker calculated from a. and b.
- d. From Table
- e. Calculated from d. and b.
- f. Estimated on the basis of data of price handbooks and other sources.
- g. Calculated from d. and f.

2. Gor'kii milling machine factory

- a. 1932, 33, 34 - Tyazhelaya promyshlennost' SSSR za 1931-34gg., op cit, p. 88.
- 1937 - Aizenshtadt & Chikhachev, op cit, p. 218.
- b. 1932, 33, 34 - as a.
- 1936 - SiI, 1936, No. 8, p. 1.
- c. Calculated from a. and b.
- d. From Table
- e. Calculated from d and b.
- f. Estimated on the basis of price handbooks and other sources.
- g. Calculated from d. and f.

3. Im. Ordzhonikidze

- a. 1932, 33 - Tyazhelaya promyshlennost'..., op cit, p. 88.
- 1934 - Calculated from 1935 output and Gudov, I, Sud'ba rabocheho, M., 1970, p. 97.
- 1935 - ZaInd., 8.1.36.
- 1937 - Aizenshtadt & Chikhachev, op cit, p. 218.
- b. 1932, 33 - as a.
- 1934, 35 - calculated from a. and c.
- 1937 - ZaInd., 9.1.37.
- c. 1932, 33, 37 - calculated from a. and b.
- 1934 - calculated from 1935 output/worker and Gudov, loc. cit.
- 1935 - ZaInd., 8.1.36.
- d. From Table
- f. Estimated on the basis of price handbooks and other sources.
- e. Calculated from d. and b.
- g. Calculated from d. and f.

BIBLIOGRAPHYA. Soviet SourcesMain books consulted:

- Acherkan, N.S.; Degtyarenko, N.S.; Frezerov, G.R., Razvitie stankostroitel'noi i instrumental'noi promyshlennosti v SSSR, Moscow, 1958.
- Aizenshtadt, L.A.; Chikhachev, S.A., Ocherki po istorii stankostroeniya SSSR, Moscow, 1957.
- Al'perovich, E.M.; Levin, E.E., Obraztsovyi zavod, Moscow, 1928.
- Anders, R.Ya., Krizis kapitalisticheskogo mashinostroeniya i import mashin v SSSR, Moscow, 1934.
- Aralov, S.I.; Shatkhan, A.S., (eds.), Promyshlennyi import - itogi i perspektivy, Moscow-Leningrad, 1930.
- Berri, L.Ya., Spetsializatsiya i kooperirovanie v promyshlennosti SSSR, Moscow, 1954.
- Bespalov, V., Bol'shaya zhizn' (iz istorii srednevolzhskogo ordena trudovogo krasnogo znamenii stankostroitel'nogo zavoda), Kuibyshev, 1949.
- Bogushevich, Yu.K.; Grebennikov, D.G., Im. Velikgo Oktyabrya (Kratkii ocherki istorii Minskogo stankostroitel'nogo zavoda im. Oktyabr'skoi revolyutsii, 1917-1967), Minsk, 1967.
- Borisov, G.; Vasil'ev, S., Stankostroitel'nyi imeni Sverdlova (ocherki istorii Leningradskogo stankostroitel'nogo zavoda imeni Sverdlova, 1867-1961gg), Leningrad, 1962.
- Byli industrial'nye (ocherki i vospominaniya), Moscow, 1970 (2nd. edn., 1973).
- Chernov, A.S., Metallopromyshlennost' SSSR, Moscow, 1925.
- 10 let Orgametalla, 1924 - 1934, Moscow, 1935.
- Direktivy KPSS i Sovetskogo pravitel'stva po khozyaistvennym voprosam, Moscow, 1957.
- Direktor - I.A. Likhachev, Moscow, 1971.
- 25 let: Eksperimental'nyi nauchno-issledovatel'skii institut metallorazhreshchikh stankov i ordena Lenina zavod 'Stankokonstruktsiya', Moscow, 1958.
- Gastev, A.K., Kak nado rabotat', Moscow, 1972.
- Gomel'skii stankostroitel'nyi (sbornik materialy k semidesyatiletiyu Gomel'skogo stankostroitel'nogo zavoda imeni S.Kirova), Gomel', 1960.

- Gosudarstvennyi proektno-tekhnologicheskii i eksperimental'nyi institut Orstankinprom 25 let, 1936-1961, Moscow, 1961.
- Granovskii, B.L.; Markus, B., Ekonomika sotsialisticheskoi promyshlennosti, Moscow, 1940.
- Grinevetskii, V.I., Poslevoennye perspektivy russkoi promyshlennosti, Moscow, 1922.
- Gudov, I. Sud'ba rabochego, Moscow, 1970.
- Industrializatsiya SSSR, 1926-1928 gg., Moscow, 1969.
- Industrializatsiya SSSR, 1929-1932 gg., Moscow, 1970.
- Industrializatsiya SSSR, 1933-1937 gg., Moscow, 1971.
- Industrializatsiya SSSR, 1938-1941 gg., Moscow, 1973.
- Industrial'noe razvitie tsentral'nogo promyshlennogo raiona, 1926-1932, Moscow, 1969.
- Istoriya industrializatsii Gruzinskoi SSR, 1926-1941, Tbilisi, 1968.
- Istoriya industrializatsii nizhegorodskogo-gor'kovskogo kraia, 1926-1941 gg., Gor'kii, 1968.
- Istoriya Kommunisticheskogo partii Sovetskogo Soyuza, Vol.4, books 1 and 2, Moscow, 1971.
- Istoriya KPSS - marksizm-leninizm v deistvie, sbornik statei, Moscow, 1974.
(especially, pp.137-154 - Volkova, R.V., "Deyatel'nost' Moskovskoi partiinoi organizatsii po stanovleniyu i razvitiyu stankoinstrumental'noi promyshlennosti v gody pervoi pyatiletki, 1928-1932 gg.").
- Kas'yanenko, V.I., Bor'ba trudyashchikhsya SSSR za tekhnicheskuyu nezavisimost' promyshlennosti, 1926-1932 gg., Moscow, 1960.
- Kas'yanenko, V.I., Zavoevanie ekonomicheskoi nezavisimosti SSSR, 1917-1940 gg., Moscow, 1972.
- Khar'kovskii stankostroitel'nyi (oчерk istorii khar'kovskogo stankostroitel'nogo zavoda imeni S.V.Kosiora, 1930-1967), Khar'kov, 1968.
- Khavin, A.F., Kratkii очерk istorii industrializatsii SSSR, Moscow, 1962.
- Kholmyanskii, I., Spetsializatsiya i kooperirovanie mashinostroeniya v pervoi pyatiletke, Moscow-Leningrad, 1933.

- Khromov, S.S., F.E. Dzerzhinskii vo glave metallopromyshlennosti, Moscow, 1966.
- Kostsov, V.P.; Vantsak, B.S., Putyami otsov, Khar'kov, 1965 (in Ukrainian) (history of the Lubny 'Kommunar' factory).
- Kuibyshev, V.V., Izbrannye proizvedeniya, Moscow, 1958.
- Kun'ko, L., Etapy bol'shogo puti (istoriya Minskogo stankostroitel'nogo zavoda imeni S.M. Kosiora), Minsk, 1958.
- Kuznetsova, N.V., Bor'ba rabocheho klassa za sozdanie novykh otraslei promyshlennosti v gody pervoi pyatiletki (iz materialakh stankostroeniya), Aftoreferat dissertatsii, Moscow, 1973.
- K voprosu tekhnicheskikh sdvigakh vo vtoroi pyatiletke, Moscow, 1932.
- Lebyachenko, I.G., Sovetskoe stankostroenie, Moscow, 1932.
- Leningradskaya promyshlennost' za 50 let, Leningrad, 1967.
- Letopis' Chelyabinskogo traktornogo, 1929-1945 gg., Moscow, 1972.
- Maevskii, I.V., Tyazelaya promyshlennost' SSSR v pervye gody sotsialisticheskoi industrializatsii, 1926-1929, Moscow, 1959.
- Makeenko, M.M., Ocherk razvitiya mashinostroeniya SSSR v 1921-1928 gg., Kishinev, 1962.
- Kishustin, D.D., Vneshnyaya torgovlya i industrializatsiya SSSR, Moscow, 1938.
- Nauchno-issledovatel'skie instituty tyazhelei promyshlennosti, Armand, A.A. (ed.), Moscow-Leningrad, 1935.
- Novosti stankostroeniya v Germanii, Moscow, 1927.
- Oborudovanie metalloobratyvatel'nykh promyshlennosti (perepis' oborudovanie promyshlennosti SSSR, 1932-1934 gg.), Moscow, 1935.
- Oboznyi, A.G., Osnovnye fondy mashinostroeniya i puti uluchsheniya ikh ispol'zovaniya, Kiev, 1962.
- Ocherki istorii tekhniki v Rossii, 1861-1917, Moscow, 1973.
- Ocherki razvitiya tekhniki v SSSR (Mashinostroenie, avtomaticheskoe upravlenie mashinami i sistemami mashin. Radiotekhnika, elektronika i elektrosyaz'), Moscow, 1970.
- Omarovskii, A.G., Sovetskoe stankostroenie i ego rol' v industrializatsii strany, Moscow, 1948.
- Ordzhonikidze, G.K., Stat'i i rechi, Moscow, 1957.

Wagoner, H.D., The United States Machine Tool Industry, 1900 to 1950, M.I.T., 1966.

Journals

Main journals consulted:

American Machinist

Engineering

The Iron Age

Machinery

The Machinist

Mechanical Engineering

Main Journal Articles:

Aldcroft, D.H., "The performance of the British machine tool industry in the inter-war years", Business History Review, Vol.XL, 1966, No.3, pp.281-296.

Brown, W.H., "Innovation in the machine tool industry", Quarterly Journal of Economics, Vol.71, 1957, pp.406-425.

Granick, D., "Economic development and productivity analysis: the case of Soviet metalworking", Quarterly Journal of Economics, Vol.71, 1957, pp.205-233.

Rosenberg, N., "Technological change in the machine tool industry, 1840-1910", Journal of Economic History, Vol.XXIII, 1963, No.4, pp.414-443.

- Orekhina, P.E., Krasnodarskii stankostroitel'nogo zavoda za 50 let, Krasnodar, 1961.
- Osnovnye linii tekhnicheskoi rekonstruktsii promyshlennosti SSSR, VSNKh, Moscow, 1929.
- Ostrovskii, Z.I., Ot Bromleya k 'Krasnomu Proletariyu', Moscow, 1937.
- Pedosov, A.D., Partiya Bol'shevikov i tekhnicheskii progress, Moscow, 1969.
- Pen'kov, P.M., Razvitie tipazha i struktura vypuska metallorezhushchikh stankov i komplektuyushchikh pri nadlexhnostei k nim v 1958 i 1959-65 gg., Moscow, 1958.
- Pervaya vsesoyuznaya konferentsiya rabotnikov sotsialisticheskoi promyshlennosti, (stenograficheskii otchet), Moscow-Leningrad, 1931.
- Proizvodstvennyi apparat stankostroitel'noi promyshlennosti SShA., Moscow, 1970.
- 15 let bor'by za sovetskoe mashinostroenie, Leningrad-Moscow, 1932.
- 50 let Krasnodarskii stankostroitel'nyi (Krasnodar stankostroitel'nyi zavod imeni Sedina, 1911-1961), Krasnodar, 1961.
- Ratsionalizatsiya promyshlennosti SSSR (Rabota komissii prezidiuma VSNKh SSSR), Moscow-Leningrad, 1928.
- Rozenfel'd, S.Ya.; Klimenko, K.I., Istoriya mashinostroeniya SSSR, Moscow, 1961.
- Rozman, M., Kapitalisticheskaya ratsionalizatsiya i rabochii klass, Moscow, 1940.
- Rubinshtein, M., Kapitalisticheskaya ratsionalizatsiya, Moscow, 1930 (3rd edn.).
- Satel', E.A., Tekhnologiya i tekhnicheskie resursy mashinostroeniya, Moscow-Sverdlovsk, 1943.
- Slavnye traditsii (k 100 letiyu zavoda 'Krasnyi Proletarii' imeni A.I. Efremova), Sogrin, G.V., Perelistyvaya stranitsy (iz istorii Chelyabinskogo ordena trudovogo krasnogo znameni stankostroitel'nogo zavoda imeni Sergo Ordzhonikidze - ocherki), Chelyabinsk, 1968.
- Sokolov, A., Sovetskoe stankostroenie, Moscow, 1932.
- Sotsialisticheskaya ratsionalizatsiya v bor'be s poteryami (po materialy RKI), Moscow, 1930.
- Sovet pri NKTP SSSR, 25-29 iyunya 1936 g., (stenograficheskii otchet), Moscow, 1936.
- Spetsializatsiya i kooperirovanie v mashinostroenii SSSR, Moscow-Leningrad, 1931.
- Stenogrammy - pervogo vsesoyuznogo soveshchaniya po stankostroeniyu, no place of publication, no date, (duplicated) (presumably, Moscow, 1933).

Strekalov, N.A., (ed.), Stanki (sbornik statei), Moscow, 1933.

Tekhnicheskii progress v mashinostroenii Ukrainskoi SSR, 1917-1967, Kiev, 1967.

Tekhnicheskaya rekonstruktsiya narodnogo khozyaistva SSSR v pervoi pyatiletke, Moscow-Leningrad, 1934.

Tsaguriya, M., Osvoenie novykh predpriyatii i novoi tekhniki v tyazheloi promyshlennosti, Moscow-Leningrad, 1934.

TsIT i ego metody NOT, Moscow, 1970.

Turetskii, Sh.Ya., Sebestoimost' i voprosy tsenoobrazovaniya, Moscow-Leningrad, 1940.

Ukolov, M.D., Stankostroitel'nyi zavod TsIT, Moscow-Leningrad, 1934.

Vedushchaya rol' rabochego klass v rekonstruktsii promyshlennosti SSSR, Moscow, 1973 (especially Chapter 4 by N.V.Kuznetsova).

Volkov, L.K.; Perevalov, E.M., Za sovetskoe stankostroenie, Izhevsk, 1933.

Zhed', M.S., Voprosy ekonomiki stankoinstrumental'noi promyshlennosti, Moscow, 1946.

Zhibarev, P.B., Industrializatsiya SSSR - veliki podvig sovetskogo naroda, Moscow,

Congresses and conferences of the CPSU

Shestnadtsataya konferentsiya VKP(b), April' 1929 goda, stenograficheskii otchet, Moscow, 1962.

XVI s"ezd VKP(b), stenograficheskii otchet, Moscow-Leningrad, 1930.

XVII konferentsiya VKP(b), stenograficheskii otchet, Moscow, 1932.

XVII s"ezd VKP(b) stenograficheskii otchet, Moscow, 1934.

XVIII s"ezd VKP(b), stenograficheskii otchet, Moscow, 1939.

Congress of Soviets USSR

VII s"ezd Sovetov SSSR, stenograficheskii otchet, Moscow, 1935.

Five-year and Annual Plans

Pyatiletnii plan narodno-khozyaistvennogo stroitel'stva SSSR, Moscow, 1929 (2nd edn. and 1930 (3rd edn.)).

Proekt vtorogo pyatiletnego plana razvitiya narodnogo khozyaistva SSSR, 1933-1937 ~~EE~~, Moscow, 1934.

Tretii pyatiletnii plan razvitiya narodnogo khozyaistva Soyuza SSR, 1938-1941 ~~EE~~, proekt, Moscow, 1939.

Narodno-khozyaistvennyi plan na 1935 god, Moscow, 1935.

Narodnokhoztaistvennyi plan na 1936 god, Moscow 1936, (2nd edn.).

Narodno-khozyaistvennyi plan Soyuz SSR na 1937 god, Moscow, 1937.

Gosudarstvennyi plan razvitiya narodnogo khozyaistva Soyuz SSR v 1939 g., Moscow-Leningrad, 1939.

Gosudarstvennyi plan razvitiya narodnogo khozyaistva SSSR na 1941 god, Moscow, 1941.

Statistics

Promyshlennost' SSSR (stat.sbornik), Moscow, 1957.

Sotsialisticheskoe stroitel'stvo Soyuz SSR, 1933-1938 gg., (stat.sbornik), Moscow-Leningrad, 1939.

Sotsialisticheskoe stroitel'stvo SSSR (stat.ezhegodnik), Moscow, 1934; 1935 and 1936.

Tyazhelaya promyshlennost' SSSR za 1931-1934 gg., Moscow, 1935.

Vneshnyaya trgovlya SSSR za pervuyu pyatiletku (stat.obzor), Voznesenskii, A.N.; Voloshinskii, A.A. (eds.), Moscow, 1933.

Vneshnyaya trgovlya SSSR za 1918-1940, (stat. sbornik), Moscow, 1960.

Statistika vneshnei trgovlya SSSR, monthly.

Machine Tool Price Lists and Catalogues

Stanki - katalog, Moscow, 1932.

Metallorazhushchye stanki proizvodstva zavodov SSSR, Stankoinstrumentsbyt, Moscow-Leningrad, 1935.

Preiskurant metallorazhushchikh stanki proizvodstva zavodov SSSR 1935 goda, Stankoinstrumentsbyt, Leningrad-Moscow, 1935.

Preiskurant otpusknykh tsen na metallorazhushchye stanki proizvodstva zavodov 1936 goda, Stankoinstrumentsbyt, Moscow-Leningrad, 1936, (2nd edn.).

Preiskurant otpusknykh tsen na metallorazhushchye stanki proizvodstva zavodov SSSR 1937 goda, NKTP, Glavstankoinstrument, Moscow-Leningrad, 1937.

Preiskurant na metallorazhushchye stanki proizvodstva zavodov SSSR 1938 goda, Narkomash, Glavstankoprom, Moscow, 1938.

Metallorazhushchye stanki - preiskurant 1940-41 gg., Glavk po sbytu produktsii zavodov NKTyazhMash., Moscow-Leningrad, 1941.

Reference Articles:Newspapers and Journals consulted:Newspapers:Ekonomicheskaya zhizn'IzvestiyaMashinostroeniePravdaTorgovo-promyshlennaya gazetaZa IndustrializatsiyuJournals:Aviapromyshlennost'Bol'shevikByulleten' konventsii sindikatov metallicheskoj promyshlennostiEkonomicheskoe obozrenieFront nauka i tekhnikaPlanPlanovoe khozyaistvoPredpriyatieProblemy ekonomikiMashinostroitel'MetallOrganizatsiya trudaSistema i organizatsiyaSotsialisticheskaya rekonstruktsiya i naukaStanki i instrumentVestnik metallopromyshlennostiVneshnyaya torgovlya

Main Journal Articles:

- Aizenshtadt, Ya., "O plane razvitiya stankoinstrumental'noi promyshlennosti v tret'em pyatiletii", Stanki i instrument, 1938, No.2, pp.3-6.
- Al'perovich, E.M., "Mirovoi krizis i problema sovetskogo stankostroeniya", SiI, 1931, No.11-12, pp.1-3.
- , "Sovetskoe stankostroenie i osvobozhdenie ot innostrannoi zavisimosti", SiI, 1932, No.2, pp.1-3.
- , "Tekhnicheskaya politika v stankostroenii", SiI, 1933, No.1, pp.1-4.
- ; "Perelomnyi moment", SiI, 1933, No.4, pp.1-2.
- , "Sovetskoe stankostroenie na novom etape", Planovoe khozyaistvo, 1933, No.7-8, pp.44-53.
- Atmakin, M.A., "Stankostroitel'naya promyshlennost' SSSR v XVIII godovshchine Oktyabrya", Vestnik metallopromyshlennosti, 1935, No.10, pp.9-21.
- Bakhrakh, N.M., "Agregatnoe stankostroenie k XVIII godovshchine Oktyab'skoi revolyutsii", Organizatsiya truda, 1937, No.10, pp.19-36.
- Bashta, T.M., "Sovetskoe stankostroenie k dvadtsatiletiyu Oktyabr'skoi Revolyutsii", SiI, 1935, No.10, pp.1-6.
- Berri, L.Ya., "Sovetskoe stankostroenie v nachale tret'ei pyatileti", Planovoe Khozyaistvo, 1938, No.9, pp.38-53.
- Boguslavskii, B.L., "Tret'ya konferentsiya konstruktorov-stankostroitelei", Sotsialisticheskaya rekonstruktsiya i nauka, 1935, No.6, pp.158-9.
- Gastev, A.K., "Peremena situatsii v oblasti stankostroeniya", Organizatsiya truda, 1935, No.6, pp.1-4.
- Gradusov, N.M., "Vybor oborudovaniya mekhanicheskogo tsekha", SiI, 1932, No.12, pp.8-11.
- Kaganovich, M.M., "Nashe stankostroenie", Bol'shevik, 1935, No.6, pp.10-19.
- Kapustin, A.N., "Osvoenie krupnoseriinogo proizvodstva stankov DiP-20 na zavode 'Krasnyi Proletarii'", SiI, 1933, No.10, pp.6-13.
- "K desyatiletiiu Eksperimental'nogo nauchno-issledovatel'skogo instituta metallorazhreshchikh stankov - ENIMS", SiI, 1943, No.9-10, pp.2-8.
- Kuperman, O., "Sebestoimost' produktsii stankostroitel'noi i avtotraktornoii promyshlennosti", Vestnik metallopromyshlennosti, 1935, No.9, pp.112-127.
- Kvasha, Ya.B., "Mashinostroenie i vosproizvodstva oborudovaniya v narodnom khozyaistve", Planovoe khozyaistvo, 1933, No.5-6, pp.37-69.
- Lazarev, V., "Aktual'nye voprosy racionalizatsii proizvodstva", Ekonomicheskoe obozrenie, 1929, No.6, pp.46-

- Levin, E.E., "Razvitie sovetskogo stankostroeniya", Organizatsiya upravleniya, 1934, No.1, pp.94-98.
- , "Tekhniko-ekonomicheskie voprosy sovremennogo stankostroeniya", Planovoe khozyaistvo, 1935, No.7, pp.13-31.
- Livshits, S., "Krasnyi Proletarii' v nor'be za osvoenie tekhniki", Problemy Ekonomiki, 1934, No.6, pp.130-139.
- Oborin, V.F., "Stankostroitel'naya promyshlennost' Anglii", Vestnik metallopromyshlennosti, 1932, No.10, pp.56-64; No.11, pp.53-56; No.12, pp.47-49.
- Orentlikher, M.F., "O meropriyatiyakh k razvitiyu nashego stankostroeniya", Byulleten' konventsii sindikatov metallicheskoj promyshlennosti, 1925-26, No.10-12, pp.154-158.
- , "Sostoyanie i perspektivy stankostroeniya", Metall, 1927, No.6, pp.74-77.
- , "Stankostroeniya", Vestnik inzhenerov, 1927, No.12, pp.542-543.
- , "Problemy stankostroeniya v SSSR", Metall, 1928, No.3-4, pp.123-128.
- , "Tekhnicheskie sdvigi v stankostroenii kapitalisticheskikh stran i nashi zadachi", Planovoe khozyaistvo, 1934, No.8-9, pp.21-32.
- , "Sovremennoe sostoyanie stankostroeniya za granitsej", Vestnik Metallopromyshlennosti, 1936, No.9, pp.101-113.
- Pankin, A., "Puti Soyuznogo stankostroeniya", SI, 1930, No.1-2, pp.2-5.
- Pivovarov, I., "Problemy stankostroeniya vo vtoroi pyatiletii", Plan, 1934, No.1, pp.30-33.
- , "Sovetskoe stankostroenie", Problemy ekonomiki, 1935, No.4, pp.189-206.
- Rozman, M., "Kapitalisticheskaya racionalizatsiya v gody krizisa i polozeniya rabocheho klassa", Problemy ekonomiki, 1935, No.4, pp.128-141.
- Shekhvits, I., "Stankostroenie v tret'em pyatiletii", Planovoe khozyaistvo, 1937, No.7, pp.32-46.
- Sorokin, M., "Proizvodstvenno-tekhnicheskie problemy rekonstruktsii stankostroeniya", Sotsialisticheskaya rekonstruktsiya i nauka, 1931, No.1, pp.104-123; No.2-3, pp.113-139.
- Tarlinskii, A., "Ot 'Bromleevskoi' masterovshchiny k bol'shevistskim metodam osvoeniya", Predpriyatie, 1933, No.12, pp.10-12.
- , "Chem bolleet Gor'kovskii zavod frezernykh stankov", Predpriyatie, 1934, No.21, pp.5-8.

"Tekhno-ekonomicheskie pokazateli po novym i rekonstruirovannym zavodam mashinostroeniya i metalloobrabotki", Vestnik metallopromyshlennosti, 1931, No.8, pp.64-75.

Telyatnikov, L., "Novelshie tendentsii v razviti stankostroeniya", Problemy ekonomiki, 1936, No.4, pp.49-68.

Volkov, S.A., "Spetsializatsiya chugunoliteinnogo proizvodstva v chetvertoi pyatiletke", Trudy Leningradskogo inzhenerno-ekonomicheskogo instituta im. V.M.Molotova, Vyp.III, Leningrad, 1947, pp.81-120.

Zernov, A.A., "Itogi i zadachi sovetskogo stankostroeniya", Sotsialisticheskaya rekonstruktsiya i nauka, 1932, No.9-10, pp.81-93.

Zinich, M.S., "Rabochie kadry tyazhelogo mashinostroeniya i stankostroeniya v gody Velikoi Otechestvennoi voyny", Istoricheskie zapiski, No.85, 1970.

-----, "Iz istorii stankostroeniya i tyazhelogo mashinostroeniya v pervoi period Velikoi Otechestvennoi voyny", Istoriya SSSR, 1971, No.6.

B. Other Sources

Books

Brady, R., The Rationalisation Movement in German Industry, University of California, 1933.

Carr, E.H.; Davies, R.W., Foundations of a Planned Economy, 1926-1929, Vol.1, London, 1969.

Ford, H., Moving Forward, London, 1931.

Granick, D., Soviet Metal fabricating and Economic Development, University of Wisconsin, 1967.

Ilyin, Y.; Galin, B., Those who built Stalingrad - as told by themselves, New York, 1934.

Moorsteen, R., Prices and Production of Machinery in the Soviet Union, 1928-1958, Harvard University, 1962.

Sutton, A.C., Western Technology and Soviet Economic Development, 1917-1930, Stanford, 1968.

-----, Western Technology and Soviet Economic Development, 1930-1945, Stanford, 1971.

Turgeon, L., Prices of Metalworking Equipment in the Soviet Union, 1928-1951, RAND, Rand Memorandum RM-1112, 1953.